THE

ELECTRICAL REVIEW.

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J. A. BERLY'S

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THE

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THE COST OF SUPPLYING ELECTRICITY.

SINCE the publication of Mr. Crompton's paper on "The Cost of the Generation and Distribution of Electrical Energy," which was read at the Institution of Civil Engineers last year, a habit has grown up of expressing all expenditure at so much per unit delivered; and although such a method is most useful in many ways, more especially when confined to the items of cost of coal, oil, and station labour, it is liable to give very misleading results if applied to all the items of expenditure without being accompanied by full information concerning plant capacity, number of lamps fixed, and annual output in Board of Trade units.

An instance of this is to be found in a contemporary where a considerable portion of the letter addressed by Chesterfield Junior to his father is taken up with comparisons between the operations of the Westminster Company and other supply companies; the net result being that we are solemnly warned not to put our trust in professors, and are informed that the City is distinctly disappointed, that Glasgow is alarmed, and that some of its leading bailies feel that a mistake has been made in consulting Prof. Kennedy *re* the Corporation lighting. We should be sorry to think so poorly of the astuteness of the leading members of the Glasgow Corporation as to believe that their faith in their own judgment should be so readily upset by the publishing of a balance-sheet, which shows that even at this early date a profit has been earned; but if it is so, we would earnestly recommend the people of Glasgow to change them as soon as possible for others who are capable of getting a better grasp of the situation.

Let us look at the figures quoted by Chesterfield Junior with the aid of a little common sense, and see if things are really so bad as he suggests. He first refers to the works' salaries and wages, which he says amount to the enormous figure of 1·59 pence per unit for the Westminster Company, as compared with ·76 pence for the St. James's and Pall Mall Company, and ·77 pence for the Newcastle and District Company. Now, if we multiply these figures by the number of units delivered, we find that in round numbers the expenditure under this head amounts to £3,800, £3,400, and £660, respectively, for the three companies; and we then see that the cost of labour at the three stations of the Westminster Company is very little more than the cost of labour at the one station of the St. James's Company, and that if the plant capacity is taken into account, the Westminster Company has rather the advantage. In a similar manner, the cost of labour at Newcastle is that incurred at one station of a capacity of about 10,000 lamps, and is therefore on very much the same level as the other two cases which have been cited. We cannot pretend to decide on the figures at our disposal, which company is the most economical, nor do we wish to attempt it; as our object is

not to advocate one company or one system in preference to the others, but to point out the fallacy of comparing the cost of labour per unit delivered without taking into account the number, capacity, or output of the stations at which that cost is incurred.

The same reasoning applies to the management expenses, which are to a very large extent independent of the annual output, and must necessarily be proportionately larger, previous to a company reaching the annual output which it is capable of supplying, than they will be at a later stage of its existence. We might here draw attention to the fact that at the end of the first quarter of last year, the Westminster Company had less than 20,000 lamps connected, that this number was increased to nearly 50,000 lamps during the six following months, and that at the present time the number is given as about 75,000, so that a considerable reduction in the cost of general management, reckoned per unit sold during the current year, may fairly be expected.

The third set of figures mentioned are the totals of works, expenses per unit, including coal, oil, &c., wages (with which we have already dealt), repairs and maintenance, and rent, rates and taxes. The last items necessarily depend on the position and capacity of the stations, and cannot fairly be compared by taking the rate per unit delivered; but the first ones, namely, coal, oil, &c., are, of all the items, those for which this kind of comparison can best be made. But even here something else must be taken into account, as the price of coal, for instance, is not the same in Newcastle as it is at Mason's Yard or Westminster, and the load factors at the several stations of the two last named companies are very different. It is well known that the St. James's Company are able to congratulate themselves on having about the best district in London, and that their load factor is a much more pleasing one than those obtained by other companies, and one naturally expects therefore, that their coal consumption will compare favourably with that of other stations.

When all the various factors which we have mentioned are taken into account, and the figures are examined carefully, it will be seen that there is no reason for alarm in Glasgow, as, although the cost per unit sold by the Westminster Company is much greater than the corresponding figure for the St. James's Company, there is no reason why the two costs, under equal conditions, should not be nearly the same, more especially since the difference between the two systems of supply is not very great; and we hope that the town of Glasgow will soon get over its fright—if it really has been seriously perturbed—and will, on thinking matters over carefully, see that deductions, either favourable or otherwise, cannot safely be drawn from the figures in the balance-sheet of any supply company, without a good deal of further information than is supplied on that sheet.

THE SPECIFICATION OF ELECTRIC LIGHT CABLES.

The discussion on Mr. Preece's paper at the Institution of Electrical Engineers came to an end last week sooner than we had expected, considering the very great importance of the subject to electrical engineers, more especially to those who are engaged in designing or operating central station supply systems, in which, as is well known, the cost of the distributing conductors form a very large item of the total capital expenditure. We had looked forward to hearing the views of several engineers who have, during the last few years, specified for and superintended the carrying out of central station systems, and we were surprised and disappointed that so few electric light cable manufacturers appeared to consider it worth their while to take part in the discussion.

Judging from the tone of the discussion, during which many of the proposals made by Mr. Preece in his paper were severely criticised, it does not appear likely that any great changes in the directions suggested will be introduced into our mode of specifying; indeed, several of the speakers, both those representing the consulting as well as the manufacturing interests, questioned the utility of attempting to specify in detail, and expressed the opinion that the best and safest way of dealing with the question was to leave it to the manufacturer, trusting that his regard for his reputation would be a sufficient inducement to him to supply the best article to meet the requirements of each case.

That this is so in the majority of cases, there can be no doubt, as few consulting engineers have had the opportunities of studying the subject in the same way that the manufacturer has; and it is probable, therefore, that in such a complex matter as the drawing up of a specification which shall by itself ensure the use of good material and appliances, the consulting engineer would leave untouched some point which was a vital part of the whole, and that by this omission he would render valueless many of the safeguards he believed he had introduced into his specification.

If, then, it is necessary to trust to the manufacturer at all, it is surely best to leave the details of construction entirely to him, and the method of procedure then becomes the following:—The consulting engineer states the area or resistance per unit length of the conductor, the pressure and current it is to work with, and the manner in which it is to be laid or erected; and, if he thinks it necessary, he states the minimum insulation resistance per unit length of the cable, and that it shall be subjected when in water to a certain pressure for so many hours. He then requests the manufacturer to send with his tender a statement of the conductor and insulation resistances he is prepared to guarantee, together with any other particulars as to dimensions and weight which may be required. If this is done, and the consulting engineer takes the trouble to be present at the tests made before delivery, and assure himself by these means that the cable fulfils the specification issued by the manufacturer, he will probably stand a better chance of getting a cable suited to his requirements than if he issued an elaborate specification drawn up by himself. There is another advantage of proceeding in the manner suggested above, which is that the greatest of all safeguards may be asked for when the manufacturer is left free to recommend the cable that seems best to him, and that is that he shall undertake to maintain the cable in good order for a stated period, of course on the understanding that it is used only under the conditions specified by the purchaser when asking for the guarantee.

As regards the adjourned discussion, it more particularly dealt with the effects of high pressures in breaking

through the dielectric, Mr. Russell quoting the results of various tests on rubber sheets and rubber covered wires, and pointing out the advantages of the high-pressure test for cables to be used at high pressures, and Mr. Swinburne drawing attention to the fact that theory indicated that a greater thickness of dielectric was required on a small wire than on a large one for the same electric pressure, the reason being that the fall of potential across the various concentric layers of the dielectric, and therefore the stress to which they are subjected, is proportional to their resistances, and that on small wires covered to a large ratio, the inner layers offer a greater proportion of the total resistance than do the similarly placed layers on a larger conductor covered to the same thickness. It would be interesting to know if this is actually found to be the case in practice, as it points to the following curious fact, viz., that for any given outside diameter of the dielectric there is a definite size of conductor which will give the best results when the cable is subjected to disruptive strain, and that any decrease in the diameter of the conductor beyond this limit, although accompanied by an increase in the thickness of the dielectric, will lead to the breaking down of the inner layers. This practically fixes a certain maximum ratio between the outer and inner diameters of the dielectric beyond which it is useless to go, as with this ratio the stress on a thin layer of the dielectric next the conductor is a minimum; so that, as copper is cheaper than insulating material, it is better to enlarge the diameter of the conductor until this ratio is reached, rather than to fill up the space with insulating material.

THE SUBMARINE SENTRY.

In the article published last week we mentioned that the sentry has an important bearing on submarine telegraphy, and we now propose to make further remarks on this matter.

The part of a submarine telegraph cable most liable to interruption is undoubtedly that laid in shallow water at the two extremities of the section. Contractors are liable to pay insufficient attention to this part of the cable because, from their point of view, it is one which presents no difficulties. A break, however, even in shallow water, frequently means a repairing ship, and consequently considerable expense. Tightness of laying, such as to leave the cable suspended over irregularities of the ground, which, although comparatively unimportant in deeper water and perhaps not preventible, is here obviously much to the danger of the cable. Soundings, the importance of which is becoming generally better recognised for deep water, are frequently neglected in shallow, where it is pretty certain they are of just as much, if not of more, importance. In deep water, variations in depth should be considered as differences of level, totally irrespective of the depth at which they occur; but in shallow this depth must carefully be taken into consideration, since it may happen that only a slight shoaling may subject the cable to the effects of tides and seas, from which it might otherwise be secure.

It is in searching for undiscovered irregularities, which are to be found only too frequently, that the submarine sentry does good service.

At the commencement of the survey for a shore end landing place, an excellent way of procedure would be to steam the ship from deep water towards shore, towing the sentry, until different depths are struck. At each of these, which we will suppose to be at 50, 40, 30, 20 and 10 fathoms, a small temporary mark buoy can be put down, and these points once determined, time can be profitably employed in steaming between the buoys and sounding.

It not infrequently happens that the off-shore incline, after falling pretty regularly to a certain depth, rises up abruptly again before plunging precipitously down to deep water. Ledges of this description are very easily missed in the ordinary way of sounding, and this might result in insufficient heavy cable being laid.

Should any sudden irregularities be found, and it be impossible to avoid them, the presence of the mark buoy enables particular care to be taken during the laying of the cable. In searching for suspected banks and shoals, out of sight of land, the use of the sentry will do away with much dangerous and tedious work, which is inevitable with the old system of sounding.

Looking to the future and foreseeing possible developments, it may not be improbable that the whole system of sounding, as at present practised, may be revolutionised by the ingenious invention of Mr. James.

Electro-Therapeutics.

The paper upon the use of electricity in the treatment of the human body, recently read by Dr. A. D. Rockwell, of New York, before the electrical department of the Brooklyn Institute of Arts and Science, contains much that is interesting, and is specially valuable from the fact that it was read by a well known and respected medical authority, before a body of non-medical scientists. That medical men (and through them the whole subject of electro-therapeutics) would derive much benefit from putting their views on medical electricity before the electrical societies more than they have done, is obvious to anyone who glances at the books written by even the best medical authorities on this topic. However sound and correct their physiology and pathology may be, their remarks on the physics of the subject generally leave much to be desired, and are often distinctly ludicrous. Until that happy time when a proper study of electricity and electro-therapeutics form a necessary part of the training of medical students, medical men ought not to allow their natural jealousy for the exclusiveness of their profession to prevent their putting forward for consideration and discussion by electricians, and especially the electrical societies, ideas and developments which for their perfection require at least as much electrical as medical knowledge. We do not know if the reading of Dr. Rockwell's paper was followed by a discussion, for our American contemporary, in which the paper appears, does not publish or refer to any, but there are several points therein upon which the views of electricians might have been expressed with advantage. The author seems far too ready to beat round the physics of his subject, and to seek fanciful explanations for effects due to simple physical facts. His reference to what in medical parlance is called the Faradic current, mixes up under that one head both currents which may be obtained from an induction coil, *i.e.*, the interrupted direct or primary and the interrupted alternating or secondary, and then he seems to wonder that the one will produce physiological and chemical effects that the other will not. He appears to hold that the different effects produced upon the body by currents from short and thick wire coils as compared with those

produced by long and thin wire coils is due to some elective influence which such currents possess inherent to themselves; and this view is still more emphasised in the author's book on electro-therapeutics, which is recognised as a standard work on both sides of the Atlantic, and has just reached its eighth edition. Of course we need hardly say there is no evidence of any such complication, on the other hand everything goes to show that the same amount of current at the same E.M.F. and at the same rate of vibration if interrupted, or the same rate of alternation if alternating, will produce the same effect upon the human body. Currents thus identical may be obtained from a variety of sources, and will always produce the same physiological, as well as chemical, magnetic, thermal and other effects. To attribute any special powers to currents generated by any special apparatus, is to encourage the quack and the charlatan, who often obtain exorbitant prices for batteries and other electrical machines on the statement that they will produce effects not otherwise obtainable. We should like to have heard from so experienced a man as Dr. Rockwell something about skin resistance, as he has evidently enjoyed special opportunities for observation on the subject, but it is not mentioned, and only indirectly referred to, though electro-therapeutists on this side of the water have laid great stress, and justly so, we think, upon the need for giving it full attention. These and other points we might mention, go to show the advantage that might arise from the discussion of electro-therapeutic problems and difficulties by electricians as well as by medical men.

The Latest Sun Spot.

A spot has recently (from the 5th to the 18th February) been visible upon the surface of the sun, which has received special attention owing to the reports received of the interference with the telegraphic systems of Russia, Sweden, the United States and Canada, and to the fine displays of aurora borealis and various magnetic disturbances which have been noticed in this country. This spot is the largest that has ever been photographed at the Greenwich Observatory, and the greatest interest has been taken in it there with a view to clearing up, as far as possible, moot points with regard to the cause and periodicity of these phenomena and the magnetic disturbances which they set up on the earth. Messrs. Lockyer, Faye, Secchi, and others, have advanced theories to account for these sun spots, but they are for the most part based upon the uncertain ground of conjecture. At the Greenwich Observatory, however, the authorities have been accumulating a large number of data concerning sun spots which are the fruits of observation, and have been preparing a valuable series of diagrams. The latter show not only that the appearance of the spots has been coincident with magnetic disturbances, but that the intensity of the disturbances has always been in exact ratio with the size of the spot. The terrestrial magnetic phenomena are very remarkable. The disturbances or "magnetic storms" are of great extent, amounting usually to several degrees. In the recently observed case, soon after the spot had passed the central meridian there was a great magnetic disturbance, lasting twenty-four hours, and being accompanied by a brilliant display of the aurora borealis on the evening which intervened. Both the vertical and horizontal movements of the magnetic needle were greatly disturbed during the recent spot period, and these perturbations have been registered by the self-recording instruments at Greenwich, showing very extraordinary irregularities. In an interview with the representative of an evening contemporary, the Astronomer Royal is reported to have said that the matter of interest now is to discuss what is the connection between the sun spots and these extraordinary magnetic disturbances. There are now three or four marked cases on record of large spots on the sun being coincident with these disturbances on the scale experienced during the past few days; but while there are no cases of a large spot being seen without magnetic disturbances being felt, there are cases in which the latter have been experienced without sun spots being visible. This might be urged as reasons against the theory of a connection between the two phenomena; but we only see what is going on on one side of the sun, and it is very possible that the spot was on the other side, so that the absence of a visible spot cannot be held to prove that there is nothing on the sun causing the disturbance. The position is briefly this: that the spots may be taken as an indication of the sun's activity—using the word as a general term—spots being always present when the sun's surface is in an active state, and, further, the activity of the sun is accompanied by an activity of the earth's magnetism. But, the sunspot which has recently passed out of view, although, undoubtedly, having much to answer for in causing inconvenience to the telegraphic systems, must not be charged with causing the vagaries of the weather which we, in common with Canada, have been experiencing. Professor Walker Smith thinks that it *is* responsible, but we must never make a charge until we have established sufficient evidence. At present we can only observe the coincidence. *Ubi mel, ibi apes*, which is as much as to say that when the sun spots appear the theories will be rampant.

Condensers in Alternate Current Working.

M. Paul Boucherot has recently issued a somewhat amended form of his interesting paper on "A System of Alternate Current Distribution at both Constant Pressure and Constant Current." We believe Mr. Blakesley was the first (or was it, M. Jablochkoff?) to indicate the possible importance of the condenser in alternate current working, both as a means of transforming and for other more obvious purposes. M. Boucherot, in his paper, shows that by means of placing a condenser and a self-induction in series across the poles of an alternator, and making the relation between the self-induction, L, the alternations, n, and the capacity, C, such that

$$4\,\pi^2\,n^2\,\mathrm{L}\,\mathrm{C} = 1,$$

we can get constant current from the terminals of the condenser no matter what be in the circuit, motors, other inductive resistances, or ordinary lamps, provided the impressed volts on the two are kept constant. The advantage of this is manifest, as we can get a constant pressure distribution for ordinary working, and, at any point in the system, a constant current by merely placing the suitable combination of self-induction and capacity across the mains. The only drawback is the fact that at low voltages a large condenser is necessarily required, and the best results will be got by making the frequency and voltage both large. As commercial condensers are now obtainable for high pressures at a moderate outlay, it is not too much to expect that before long these will form a necessary part of all alternate current stations. When this is the case, Mr. Boucherot's system would be well deserving of the notice of some engineers; he has himself applied it with some measure of success.

The Correlation of Electricity with Heat.

Mr. Tolver Preston is again to the fore with his favourite ether, and in *Engineering* of last month, gave a short article in support of his idea that ordinary radiant heat waves and those thrown off in electric circuits are the same in all respects except wave length. This, in its broad sense, is certainly true, as it is not philosophical to draw the line anywhere between the waves of light with wave lengths, reckonable only in tenth-metres, and those of radiant heat, or even the longer ones spoken of by Mr. Preston, which may be hundreds of miles in length. There is a difference,

however, between the possible long waves he suggests are thrown off by the sun, and those thrown off by an alternate current dynamo. In the former case, as far as we can judge, not much of the energy returns; in the latter (as in Hertzian waves) the greater part of the energy merely surges to and fro. It is well that we have papers of this sort published now and then, as it leads people to clearer ideas on the subject of ether motions, and the important part they play even in practical engineering problems.

Correction.

In our issue of September 11th, 1891, under the heading of "Electricity in New South Wales," we published a paragraph which, certainly unknowingly to ourselves, but nevertheless most unfortunately, contained statements calculated to do a leading and enterprising Australian firm serious injury. Our only excuse is that we relied solely upon our correspondent. In commenting upon electrical affairs at Broken Hill, N.S.W., we stated that "the municipal council, wishing to have some expert opinion as to how work was going on, called in a Melbourne firm of electrical contractors, Messrs. Booth and Ellson, instead of appealing to an independent consulting engineer. Messrs. Booth and Ellson presented an unfavourable report, more especially upon the overhead wiring, and the contractors for the work, Messrs. Westcott, Marshall and Adams, were accordingly communicated with. Mr. Hitchcock, a Westinghouse expert, who is superintending engineer to the contractors, in replying, affirmed that the condemnatory report was written for interested motives. He states that the cable is especially adapted for the Barrier climate, and for safety and durability is superior to many other cables in use for the same work in other parts of the world. As the cable in question is 'Callender's,' a brand which already has a firmly established reputation in the Colonies as elsewhere, Mr. Hitchcock certainly seems to have good foundations for his assertions." We are now informed on the best possible authority, that Messrs. Booth, Ellson and Company, of Melbourne, have been in business as independent consulting electrical engineers for years past, and are in no way connected with any firm of contractors or manufacturers, and that the Broken Hill Municipal Council called their firm in for this reason, and not only accepted their report, but passed a resolution allowing the company to go only on condition that the recommendations of the report were duly carried out. Our readers will see how essential it is to such a firm that no doubt be cast on their impartiality, and that they are known to be free of connection with any contracting firm. It is for this reason that we give publicity to the true nature of their business. With regard to the wires incidentally mentioned, these were certainly of the well-known "Callender" make, but being of the class described, "light insulation, no insulation resistance guaranteed," were not passed for high tension primaries.

Electric Motive Power.

There are two aspects from which the electric transmission of motive power may be regarded, one is, its advantages as regards the help which it gives of enabling natural sources of energy (situated at a distance from the place at which that energy is to be utilised) to be made use of; and the other, the economy which it effects when distribution of power from a steam engine has to be carried out. The latter is daily becoming to be more recognised, and the use of miles of shafting in factories, with all its attendant waste, will give way to the employment of cables packed away underground; whilst the heavy erections necessary to support the shafting will also vanish. Already, we believe, one well-known electrical works are intending to generate and transmit power and light the whole of their extensive premises from their own central electric station at a large estimated saving of annual expense. The experiment (though, perhaps, it can hardly be regarded as such) will be looked forward to with great interest, and if it prove as successful as imagined, will, no doubt, give a considerable impetus to others to follow the example. One of the most complete examples of the kind appears to be the Schenectady Edison Works, America, where nearly 2,000 H.P. is being, or is to be, transmitted by wire from a central station, the work to be done varying from a $\frac{1}{12}$th H.P. dental drill up to a 120 H.P. double mining pump.

Verbum Sap.

It is not necessary for us to defend the reputation of the Brush Electrical Engineering Company, but the remarks made by Mr. Commissioner Kerr, when disposing of the suit brought by the company against Messrs. Satchwell & Co., merit more than passing notice. Mr. Kerr's eccentricities are well known, and although he occasionally delivers a judgment which strikes one as being eminently opposed to law and reason, yet, on the other hand, his honesty of purpose, his aversion to roguery or misrepresentation of every kind, and his sound common sense, enable him to mete out strict justice in the majority of cases which come before him, although his comments do not always give a fair idea of the characters of the litigants. That his judgment was correct in the case under notice no one is likely to deny, and we trust that it may be the means of putting an end to that mania for fitting up electric light leads and lamps when the means of utilising them do not exist.

Fluid Insulation.

Some months ago the New York *Electrical Engineer* contained an article by Mr. F. L. Pope, on the employment of oil as an insulator for high potentials, in which he attempts to show that the idea of immersing a transformer or a bobbin in a hydrocarburetted liquid seems to be due in the first instance to David Brooks, who obtained a patent for the same in the United States, December 17th, 1878. Our well-known correspondent, Mr. A. M. Tanner, in a communication to *L'Industrie Electrique*, proves, however, that the claim of priority for Brooks's invention cannot be maintained, seeing that Jean's experiments were published in 1858, in the *Comptes Rendus de l'Académie des Sciences*, A.D. 1858, Vol. xlvi, page 186, where we read as follows:—"M. Jean publishes, in the following terms, the results obtained with the induction coils constructed by him. By insulating the induced wire of the induction coils, Ruhmkorff system, with melted resin or simply with spirit of turpentine, we can obtain from them sparks, the intensity of which increases with that of the inductive current within a considerable limit." In the bulletin of the Society for the Encouragement of National Industry, 57th year, January, 1858, Vol. v., p. 232, we find M. du Moncel's report: "M. Jean has recently effected some improvements on M. Ruhmkorff's apparatus. The apparatus is arranged vertically in a stone vessel of about the same dimensions as the bobbin and exceeding it a little in height; then the vessel itself is filled with spirit of turpentine, so that the entire bobbin, including even the core of iron wire occupying its centre is completely immersed in the spirit. One of the greatest advantages of M. Jean's bobbins is that they allow of the indefinite addition of elements to the battery, without involving any deterioration of the apparatus. We can understand, in fact, that if the tension of the induced current becomes such that the layers of cotton and paper insulating the different rows of spirals of the helix are traversed and pierced by sparks which could then pass directly between the inner and the outer spirals, the insulator would still remain, as these holes would be immediately stopped up by the liquid spirit. Thus every advantage is to be gained by using M. Jean's method."

THE ELECTRIC LIGHT AT BUDAPEST.

[FROM OUR OWN CORRESPONDENT.]

The sub-committee entrusted with the examination of the tenders for the lighting of Budapest has already concluded its labours, and has resolved to grant the concession to *two* undertakings, viz., the local gas company and the firm of Ganz & Co., at Budapest. The committee has been influenced by the notion that the supply of electric energy in the city should not be a monopoly, but that there should be created a competition beneficial for the consumers. But from a a municipal point of view it has been unwilling to lay down too many leads in the streets, and has confined itself to two electrical works. In order, however, to secure for consumers the advantages of a real competition, both these undertakings shall be bound to instal, forthwith, leads in all the main lines of streets, and, without regard to distance, to furnish all intending consumers with electric energy as soon as a certain minimum demand is guaranteed.

A technical opinion which has been handed in to the committee by its expert, Herr Wiltman, professor at the Polytechnicum, of Budapest, on the technical values of the tenders, and is not without interest. The most important portions of this document are as follows :—

It is regarded as decisive that it is desirable that current should be distributed from the central station without difficulty and without inconvenience to the inhabitants to all points of the city, even the most remote.

As such an installation, completely equipped, requires many thousand horse-power in machinery and boilers, it is advisable, if possible, to erect the central station outside the city. This is desirable, not merely on account of the first cost but of the working expense. The installation could also be extended much more easily outside the city, as within the limits difficulties as regards space have to be constantly encountered. Outside the city the conveyance of fuel, the removal of ashes, the supply of feed, and condensing water, is more easy, and the costly installations for the consumption of smoke can be dispensed with. Nor is it necessary to use such expensive fuel as coke or anthracite. All the contractors have seen, more or less clearly, the necessity of installing the central station outside the densely-peopled parts of the city, and, in their tenders, have taken that fact into account.

The system to be adopted must ensure freedom from dangers to life, to health, and to property. The consumers must not be dependent upon each other as regards the use of current. An extension of the installation and of the region of consumption must appear practicable, and the utilisation of the current must be as simple as possible. To experts it must also seem desirable that a system of transmission to a distance should be adopted, so that the entire territory of the city may be supplied from a single central station.

In characterising the transmission to a distance, the expert examines *seriatim*, the most important systems of distributing current.

The distribution of current may either be direct or it may be effected by transformers or by accumulators.

The systems which may at present come under consideration for the Capital are the 3-lead and 5-lead system, with or without accumulators, working with a continuous current ; the system which works with batteries of accumulators introduced in series ; the system of continuous current transformers with or without accumulators ; the alternating current systems with transformers arranged either in series or in parallel ; and, lastly, the system working with a multiphase current.

The opinion enters successively into the details of all these systems, and concludes with the decision that "the systems working with transformers arranged parallel, have essential advantages as compared with other systems if it is required to supply an extensive city with current from a central point."

In the further course of his expositions, the expert discusses the methods of utilising the current, whether for lighting with glow and arc lamps or for motive power purposes.

As regards glow lamps there is no difference, whether they are fed with continuous or alternating currents. With arc lights the case is different, as an equal quantity of light can be supplied more cheaply by an alternating current than by a continuous current. (The expert calculates the hourly consumption of current of a 6 ampère arc light with the continuous current at 15·68 kr., but with an alternating current at 11·66 kr.)

As concerns the utilisation of electric power for industrial purposes the expert thinks he may assert that it can scarcely supersede steam power. As regards the importance of the electric current for the smaller manufacturers, it has been found on inquiry in Berlin and Vienna that the demand is small in comparison with that for lighting purposes. Still it must be remembered that these conditions are variable, and that a more important sphere may open up for electricity as a motive-power. It is remarked that the alternating motor in its applications is open to restrictions which do not occur in case of continuous current motors.

To the question whether it is advisable to take the current needed for propelling the cars on electric tram-lines and that for lighting from one common source, the expert replies that the cable of the electric tram-line lies in an underground channel, where, on account of rain, earth-conductions or short circuits may occur which will disturb the action of the lamps. Hence the question must receive an answer in the negative.

The expert finally recommends that in deciding upon the tenders the condition should be put forward that the concessionary is bound to supply current to all who demand it, provided always that the parties guarantee a sufficient consumption of current along any new extent of lead. He also suggests that the installation for generating current should be placed in a part of the city suitable for manufacturers. Without doubt the supply of current for the whole city can be most conveniently effected from a single central station—a condition which is best effected by means of a system of distant conduction working with alternating-current transformers.

I, says he, have arrived at this conviction on the basis of thorough-going study and personal experience. I have had the opportunity of examining personally and closely inspecting several of the largest central stations working with alternating current transformers, among others those of Vienna and Cologne, and have formed the most favourable opinion both as to the manner of their arrangements and the simple and certain action of these installations.

These observations seem to me the more decisive, as I have also had the opportunity, both in Vienna and Berlin, of examining central stations founded on another manner of distributing the current, so that I have been in a position for comparing the various systems.

I am further confirmed in my judgment by the fact that all the parties tendering have kept the application of the alternating system in view for the case of supplying the entire municipal territory with electric energy.

I am of opinion that it would be most advantageous from the outset to carry out in a unitary and fundamental manner that system which is projected for the case of an extension of the installation. In this manner the risk would be avoided that in time the Capital might become possessed of a conductive net devoid of every organic connection.

We have further shown that for illuminating purposes the continuous and the alternating currents are of equal value, although as regards supplying arc lamps from a central station, if we maintain certain methods of arrangement, the alternating current is the more advantageous. Electric energy for the distribution of motive power may be utilised either with a continuous or with an alternating current. The continuous current may be applied directly for electrolysis and for charging accumulators, and the alternating current may produce the same results by the intervention of electro-motors.

From the above it follows that for the choice of a system the decision, from a technical and economical point of view, turns on the question in what manner the distribution of electrical energy to great distances and over widely-extended territories can be most appropriately effected.

As I have already explained in my introductory exposition, the choice of the system to be adopted concerns not only the party undertaking the work but also the Capital which grants the concession, for which it is important that such concession is accorded to a system which solves the problems connected with the distribution of current in a unitary manner which is in every respect on the level of the technical progress of the day and is based upon a solid foundation.

A PHASE IN THE "DISSOCIATION" CONTROVERSY.

The champions of the dissociation theory now hold that the act of dissociation of compounds evolves heat, the evolution being due to the combination of electric charges within the atom. Those who remember the form in which the theory was first put forward, will see that this is in direct opposition to Arrhenius's original view; and there are those who say that the founder of the dissociation hypothesis will soon be unable to recognise that which is being called by his name. Of course it is in the nature of theories to develop and often to receive important modification, but some consistency must be preserved, or the credit of a new theory will suffer: the supporters must not shift their ground too often.

Mr. S. U. Pickering has, perhaps, from the first, been a stout, shall we say, opponent of the new theory, and he has done good service, even should it turn out to be true, in sifting the statements upon which it is based, and in forcing the supporters of it to strengthen their position or to retire from weak points which they are unable to defend.

In the "Philosophical Magazine" (series 5, Vol xxii., pp. 20-27) Mr. Pickering raised the question as to the origin of the electric charges alluded to above, in the absence of the expenditure of external energy, and the absence of friction, induction, and contact difference of potential. He also inquired how an affection of matter, to wit, a charge can combine with matter itself to produce heat and yet itself remain *in statu quo*; and how the opposite electrification of the different atoms can, contrary to the older electro-chemical theory, dissolve the union between them.

Both this view, and that of the ions, being "allotropic atoms" with less internal energy than ordinary atoms, was characterised by Mr. Pickering as an hypothecation of a new form of matter to satisfy a theory which is, according to the opponents of the dissociation theory, inconsistent with known matter, or as a "verbal alteration designed to conjure away a stock of energy, so that the theory may not be said to be contradicted by the principle of the conservation of energy."

He contrasted the present hypothesis of Arrhenius with that of Clausius which requires only the presence of a few atoms freed by accidental super-heating, or else the continual interchange of atoms between contiguous molecules. The presence of any free atoms, however, he held to be opposed to the fact that molecules of the elements are not formed in solutions, and he suggested that polarisation currents may be explained by a "coating of orientated molecules not atoms."

In the *Berichte der deutschen chemischen Gesellschaft* (xxiv., p. 1,579), Mr. Pickering returned to the attack and argued that he had established it as a fact that weak solutions of sulphuric acid and other substances in water contain less, instead of containing more, acting units than the acid and water separately, thus showing that the association, and not the dissociation theory is the more likely to be true.

A paper by the same author in the *Berichte*, Vol. xxiv., pp. 3,317-3,327, again refers to this alleged fact and states that it cannot be brought into harmony with the dissociation theory as Arrhenius (*vide Berichte*, Vol. xxiv., pp. 2,255-2,264) appears to consider, by admitting that complex aggregates of similar molecules exist in pure liquids and in strong solutions.

In the same paper Mr. Pickering deals with some recent criticisms of Arrhenius, and then goes on to give a preliminary statement of numerous results obtained in an investigation of the freezing points of strong solutions.

It is a well-known fact that very weak solutions of electrolytes exhibit an abnormally large molecular depression of the freezing point; this decreases as the strength is increased up to a certain point; but when this stage is reached it again increases, and often attains values which are abnormally large in a very high degree.

The non-electrolytes appear to behave in the opposite manner. In every case that Mr. Pickering has investigated, the molecular depression exhibits a decrease according as the strength of the solution is lowered, although in a few cases this abnormally small depression is preceded by a slight and temporary increase. Now, although the so-called dissociation may offer some explanation of the behaviour of very weak solutions, it appears to be incapable of explaining that of stronger solutions; for here the molecular depression increases, while the amount of dissociation, as measured by the electrical conductivity, diminishes.

The abnormally high values which have been obtained by Dr. W. H. Perkin and by Dr. J. H. Gladstone, the former for the magnetic rotation of many salts, &c., in strong solution, and the latter for their refractive indices, is probably due to the same causes (according to Mr. Pickering) as those owing to which these solutions exhibit an abnormally large depression.

A table is given in which the magnetic rotation values are compared with the amount of dissociation existing, and there appears to be no connection whatever between the two.

Evidently we have by no means heard the final word on either side of the question at issue between the dissociationists and the associationists; and the discussion which has been prosecuted with such vigour by the supporters of both theories, and is still continuing, affords an interesting illustration of the way the truth is thrashed out by scientists in these *fin de siècle* days. Had our eighteenth century predecessors exhibited the same method and used the same energy, what progress there would have been to record!

THE RAPID CALCULATION OF MAGNETO-MOTIVE FORCES.

The mode of calculation adopted up to the present for the determination of the magneto-motive forces necessary to maintain a given magnetic flow in a circuit is generally somewhat complicated and laborious, for it takes into account permeabilities, magnetic resistances and magnetising forces in C.G.S. units, whereas practically what we want to know is the magnetomotive force in ampère-turns. M. Steinmetz's recent study of the law of hysteresis, writes M. Hospitalier in *L'Industrie Electrique*, has suggested to us the idea of simplifying these calculations by drawing up a table of the magnetising forces necessary to produce a given induction in a magnetic circuit, the nature of which is known (air, soft iron, cast iron, &c.) This table gives the values of the magnetising forces in ampère-turns per centimetre, so that in order to determine in ampère-turns the magnetomotive force, F, necessary to produce a given induction, B, in a circuit of given length, l (in centimetres), all we have do is to multiply the value of the magnetising force, K, indicated in the subjoined table by the length of the circuit, l, in centimetres.

$$F = K\,l.$$

Table of Magnetising Forces as a Function of the Induction.

Induction.	Magnetising force, K. In ampère-turns per centimetre.		
B	Air.	Cast iron.	Soft iron.
1,000	800	...	...
2,000	1,600	...	...
3,000	2,400	...	...
4,000	3,200	4	...
5,000	4,000	8	1·6
6,000	4,800	17·2	1·95
7,000	5,600	33·6	2·3
8,000	6,400	64·0	2·7
9,000	7,200	101·6	3·2
10,000	8,000	150·4	4·0
11,000	...	233·6	5·2
12,000	...	...	6·8
13,000	...	...	9·6
14,000	...	...	13·6
15,000	...	...	22·8
16,000	...	...	41·6
17,000	...	...	84·0
18,000	...	...	150·0
19,000	...	...	280·0
20,000	...	...	...

Example.—We will take a dynamo, the *entrefer* of which throughout its length is 2 centimetres thick (B = 3,000), the cast-iron inductors are 50 centimetres long (B = 8,000), and the soft iron armature is 40 centimetres long (B = 15,000); we have to determine the total magneto-motive force. We have:

	B.	K.	l.	F.	
For the *entrefer* ...	3,000	2,400	2	4,800	ampère turns.
For the inductors ...	8,000	64	50	3,200	„ „
For the armature ...	15,000	22·8	40	912	„ „
Total ...				8,912	

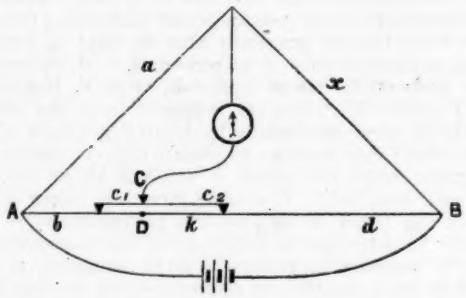
The magnetic constants determined by Dr. J. Hopkinson when presented under this new form, give at once the numerical values of the magnetomotive forces necessary to overcome the individual magnetic resistances of each part of the circuit, and also show those upon which we can act most effectively to modify the properties of the apparatus in view of a given result.

We think it will be of service to constructors of dynamos, motors, and transformers, to publish the above table, which will facilitate their calculations, as well as the sketching out of the characteristics as a function of the ampère-turns of excitation.

THOMSON AND VARLEY SLIDE-RESISTANCES.

BY ROLLO APPLEYARD.

THE following proof of the equation for the Thomson and Varley slide-bridge (Kempe, p. 210), makes the relation between the resistance of the various conductors at once apparent.



In the figure, a represents the fixed resistance; x, the unknown resistance; $b + k + d$ is the first slide resistance; and $\rho_1 + \rho_2$ is the subdivided resistance. It is assumed that the position of the sliding contacts is found, so that no current passes through the galvanometer. Then, since the resistance of $\rho_1 + \rho_2$ is the same as that of k, and no current flows from $(\rho_1 + \rho_2)$ at the point, C, there is the same fall of potential along each of these conductors. Hence, we can assume a point, D, in the resistance, k, dividing k in the ratio ρ_1 to ρ_2, which is at the same potential as C. If we suppose C joined to D, which will not alter the currents in the network, as C and D are at the same potential, it is clear that the resistance between A and this point is $b + \frac{\rho_1}{2}$, and between this point and B we have $d + \frac{\rho_2}{2}$, and we may write the equation of the bridge in the usual form.

$$\frac{a}{x} = \frac{b + \frac{\rho_1}{2}}{d + \frac{\rho_2}{2}}$$

The German Telegraph Bill.—This bill has now passed through the hands of the committee and will shortly be considered by the the Imperial Diet. It scope was considered by the Electrotechnical Society of Berlin on the 22nd ult., when Mr. Lahmeyer and others discussed the subject. A commission was subsequently appointed to call either an extraordinary meeting of the members or a public assembly of technical men to deal with the matter.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

SOME EXPERIMENTAL INVESTIGATIONS OF ALTERNATE CURRENTS Read by Mr. ALEXANDER SIEMENS, Thursday, February 11th, 1892.

MOST of the papers read before this Institution on the subject of alternate electric currents, and on apparatus employed for utilising them, have dealt principally with the theoretical side of the question, and undoubtedly have been extremely useful to constructors of alternate-current apparatus. Nevertheless, certain gaps in our knowledge obtruded themselves in practice, and the investigations and experiments which are described in the present communication were undertaken, not so much to verify any particular theory, as to increase our knowledge of useful facts.

For convenience of reference, these experiments are not described in chronological order, but they have been grouped together according to the subjects which they are intended to elucidate. Foremost amongst these is the loss of energy through the heating of iron by induction where alternate electric currents are employed—a subject which engaged the attention of Prof. Ewing and of Dr. J. Hopkinson six years ago, whose researches pointed out the direction in which further experiments should be made. It is well known that this loss is caused by the so-called Foucault currents and by hysteresis. The effect of the former is counteracted by laminating the core of a magnet either by building it up with wires of small diameters or with thin discs, according to the direction of the lines of induction.

A short consideration will show that the heat produced by Foucault currents can be calculated beforehand for a core of known construction and dimensions.

Take the case of an iron wire, 1 cm. long, subjected to an induction parallel to its axis of B lines per 1 square cm. of its section.

Let r be the radius of the wire, and ρ the radius of a ring, of the width, $d\rho$, concentric with the wire. In this ring currents will be produced in the same manner as in the secondary circuit of a transformer.

The maximum induction passing through this ring is $N = \rho^2 \pi . B$. Hence the electromotive force generated is $E = 4 n N \times 10^{-8} = 4 n \rho^2 \pi B 10^{-8}$ volts.

If c is the conductivity of the iron employed, the resistance of the ring is $R = \frac{1}{c} \times \frac{2\pi\rho}{d\rho}$; consequently the waste of energy in this ring, expressed in watts, is

$$d W = \frac{E^2}{R} = 8 c \pi n^2 B^2 \rho^3 d\rho . 10^{-16}$$

The total energy wasted in one cm. length of the wire is therefore

$$W = 2 c . \pi . n^2 . B^2 . r^4 . 10^{-16} \text{ watts.}$$

From this formula a table has been calculated to indicate the waste of energy by Foucault currents in 1 cwt. of iron of the conductivity $c = 0{\cdot}102 \times 10^6$, when an alternate current of the frequency $n = 100 \sim$ per second was employed.

Induction.	Diameter of wire.			
B	½ mm.	1 mm.	2 mm.	3 mm.
1,000	0·8 watts	3·3 watts	13·3 watts	29·9 watts
2,000	3·3 „	13·3 „	53·3 „	119·9 „
3,000	7·4 „	29·9 „	119·9 „	269·8 „
4,000	13·4 „	53·3 „	213·3 „	479·8 „
5,000	20·8 „	83·3 „	333·2 „	749·7 „
6,000	29·9 „	119·9 „	479·8 „	1,079·4 „

In order to determine the total loss of energy caused by the heating of the iron, experiments were made with a specially constructed "cable transformer."

This mode of constructing transformers has been foreshadowed by Dr. Werner von Siemens, who proposed in his patent, No. 42 of 1886, to surround the primary and secondary circuits of a transformer with iron wire, but his experiments gave no satisfactory results.

The subject was recently taken up again, and the present form of these transformers was suggested by Mr. Dieselhorst and Dr. Baur.

The principal advantage which is claimed for this form of transformer is that it can be made by machinery, in the same way as a submarine cable is made, the employment of manual labour in putting it together being entirely avoided.

A special machine has been designed and erected for completing such transformers in one operation, after the iron core has been prepared on an ordinary rope stranding machine.

Besides offering these facilities for manufacture, the peculiar shape of the cable transformer lends itself to a variety of useful applications.

For instance, at the Crystal Palace Exhibition one of these transformers connects an alternate current machine to a high voltage transformer some distance away, raising the potential of the current at the same time from 80 volts to 2,500 volts.

The transformer used for the experiments has a core of 900 soft iron wires, each 1 mm. in diameter by 6 metres long, twisted up in the form of a rope, and surrounded by two windings of copper wire, properly insulated, the one for high voltage and the other for low voltage.

From the fact that the diameter of the transformer is very small compared to its length, it follows that the magnetic field, and consequently the induction in the iron core, is uniformly distributed, with the exception of a slight drop at either end.

The mean induction produced by passing an alternate current through the low voltage circuit was measured by the difference of potential obtained in the high voltage circuit while no current was passing through the latter.

The temperature of the iron core was ascertained by measuring the increase in the electrical resistance of one of its wires, which had been insulated from the rest by a cotton covering.

By actual comparison it was found that one of the wires near the periphery gave, within the limits of errors of observation, the same results as the central wire, so that the exact position of this "test wire" has no influence on the result; the heating of the cotton insulation can be neglected, as its mass is so very small compared with that of the iron.

Separate tests were made to determine the specific heat of the iron, which was found to be = 0·112, and the temperature coefficient for the electrical resistance of the test wire, which was equal to 0·0054.

The current was kept on for a short time only, as it was desired in the first instance to determine the rate at which energy is converted into heat in such a transformer, and the rise in temperature after keeping the current on for s seconds can be calculated from the formula,

$$t_s = \frac{R_s - R_0}{\cdot 0054 \, . \, R_0}$$

R_0 = electrical resistance before starting the current; R_s = electrical resistance after keeping the current on for s seconds.

During the time that the current passes, the test wire will lose a certain amount of heat by radiation and convection, although it is surrounded by all the other iron wires, which are heated in a similar manner. This loss can, however, easily be allowed for by plotting a "cooling curve" after the passage of the current has been stopped, with times as abscissæ and temperatures as ordinates. In this way the rise of temperature of the iron core per second was observed with an alternate current of 100 ∿ per second, varying in strength so as to produce a different induction for each observation.

Considering that the loss of energy caused by the heating of the iron is proportionate to its mass, to its specific heat, and to its rise of temperature per second, it was possible to plot a curve in which the maximum number of C.G.S. lines per square cm. are the abscissæ, and the losses of energy are represented as ordinates calculated for the mass of 1 cwt. of soft iron wires 1 mm. in diameter.

The losses caused by hysteresis are independent of the dimensions of the iron; this table enables us, therefore, together with the formula for the losses caused by Foucault currents, to predetermine the rate of the loss of energy in iron wire of any weight or dimensions when acted upon by an alternate current of a frequency equal to 100 ∿ per second.

Similar experiments were made with alternate currents of a frequency of 66·6 ∿ per second, and of a frequency of 133·3 ∿ per second, and the curves embodying the results shown.

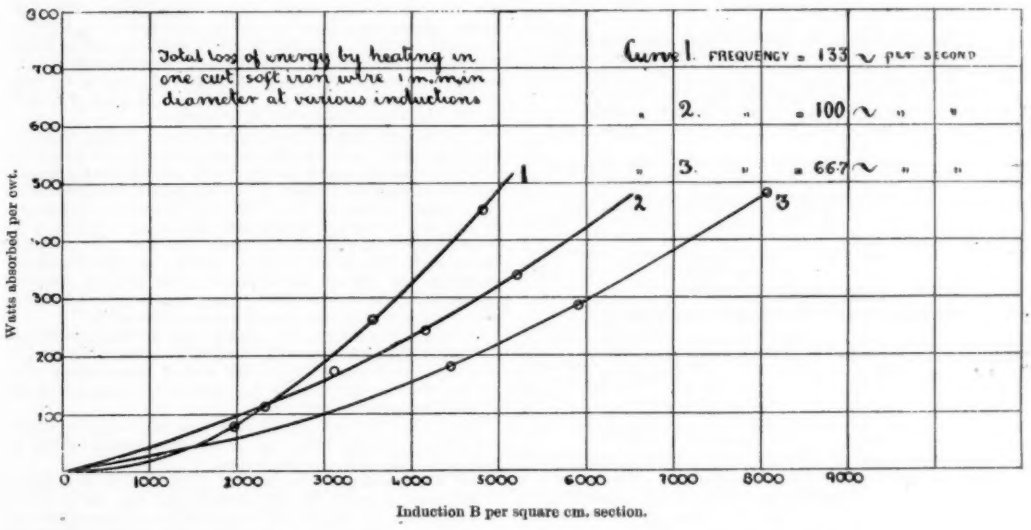
It should be observed that the currents of 66·6 and of 100 ∿ were obtained from the same alternate current machine (type W_I), which has a high self-induction in the armature, and of which it has been ascertained experimentally that the waves of its current are sinoidal.

The current of 133·3 ∿ per second was produced by another type of machine (W_{II}) with a low self-induction and a very narrow field.

The losses by hysteresis alone have been shown, derived from the above curves, by deducting the losses caused by Foucault currents according to calculation. By way of comparison, Prof. Ewing's curve of losses caused by static hysteresis has been added. In this table the results obtained with alternate currents of 133·3 ∿ per second have been left out of consideration, on account of their being made with a different machine, as just explained.

The next point to be investigated is the change which an alteration of the frequency of the current will involve in the case of a transformer designed for a given voltage in its secondary circuit. If it is borne in mind that this voltage, apart from the constant factors, depends on the product n N (n denoting the frequency, and N the maximum number of lines of induction), it follows at once that in order to produce the same E.M.F. with a lower frequency the number of lines of induction has to be increased in proportion, and *vice versâ*. In other words, if the same E.M.F. is to be produced in the secondary circuit of a given transformer, the product, n N, must be constant. This result can at once be applied to the formula, which gives the losses of energy caused by Foucault currents—

$$W = 2 \, c \, \pi \, n^2 \, B^2 \, r^4 \, 10^{-16};$$



It should be added that the abscissæ of curve 2, which embodies the results obtained, have been calculated from the measured volts, instead of from the calculated mean volts, which in sinoidal waves are = 0·9 measured volts.

This was done as curve 2 was to be used for designing transformers where the measured volts only are used for calculation.

As this curve gives the losses caused by hysteresis and by Foucault currents, while the formula given above enables us to calculate the losses caused by the Foucault currents alone, we can determine the loss by hysteresis alone by a simple subtraction.

All these results, it must be remembered, refer to 1 cwt. of soft iron, subdivided into wires of 1 mm. diameter, on which an alternate current is acting of a frequency of 100 ~ per second, the type of apparatus used being a cable transformer.

The following table shows the results:—

Induction.	Losses of energy.		
B =	Curve 2.	Foucault currents.	Hysteresis.
1,000	43·2 watts	3·3 watts	39·9 watts
2,000	96·2 "	13·3 "	82·9 "
3,000	158·0 "	29·9 "	128·1 "
4,000	231·2 "	53·3 "	177·9 "
5,000	309·5 "	83·3 "	226·2 "
6,000	390·1 "	119·9 "	270·2 "

and as $N = r^2 \, . \, \pi \, . \, B$, the formula can be expresed—

$$W = \frac{2 \, c}{\pi} \, (n \, N)^2 \, 10^{-16};$$

or, in other words, these losses are constant for the same transformer, whatever the frequency may be, as long as the E.M.F. of the secondary circuit remains the same.

A comparison of the curves for a frequency of 66·7 and of 100 ∿ per second shows that the losses of energy for the same induction are practically proportional to the frequencies. The same curves show that this loss increases more rapidly than the number of lines of induction.

From this consideration it follows that a transformer which has been designed to produce a certain E.M.F. in its secondary circuit with a given frequency cannot produce the same E.M.F. with a lower frequency without over-heating, while it remains cooler when it is worked with a higher frequency. In other words, transformers built for low frequency require much material.

An experiment was made to ascertain the final temperatures of a 50 H.P. transformer worked with different frequencies, and after 10 hours' working the maximum temperature was found to be—for a frequency of 100 ∿ per second, 53° C. in the core, and 46° C. on the outside; for a frequency of 66 ∿ per second, 69° C. in the core, and 57° C. on the outside—a result which appears to bear out the above consideration.

What frequency is most advantageous can, however, not be settled by taking into account nothing but the heating of the transformers;

it is quite evident that the construction of suitable generating apparatus plays as important a part; and the problem resolves itself into the commercial one, which combination of apparatus can be constructed most cheaply?

The question, what induction should be settled upon in designing a transformer is rather a complex one, and it can only be solved by taking into consideration—

1. The amount of material, iron and copper.
2. The drop of potential difference in the secondary circuit from no load to full load.
3. The efficiency of the apparatus.
4. The heating of the apparatus.

In order to facilitate the investigations a series of transformers is compared which all have the same length of iron core, and the same number of turns of copper wire of the same diameter.

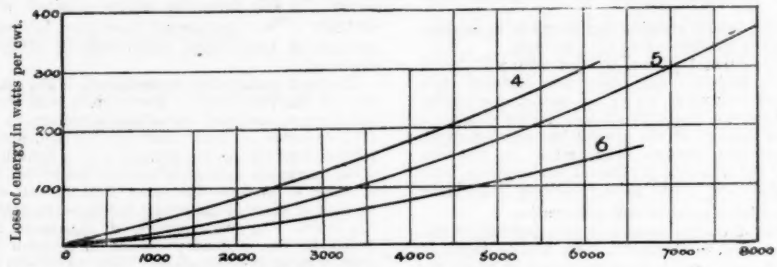
It is assumed that one of these transformers is designed for an induction B = 5,000, and that its output is such that the weights of the iron and of the copper used in its construction are equal to each other and to 1 cwt.; this may be called the normal transformer.

As materials are important items in the cost of a transformer, the consideration of the first point shows the desirability of employing a strong induction. A similar conclusion will be drawn from the investigation of the relation between the induction and the drop of difference of potential in the secondary circuit of the series of transformers. As they are all supposed to give the same current, the drop from no load to full load will be in proportion to the resistance of the circuit. This resistance is in proportion to the weight of copper employed, as all the transformers are assumed to be wound with wire of the same diameter. The curve (8) giving the weight of copper at different inductions will therefore also indicate, in comparison with the normal transformer, the variation in the drop of potential between no load and full load under the same circumstances.

In order to determine the variation of the efficiency of the transformers under investigation, it is necessary to treat separately the losses in the iron and in the copper. The former can be found by the aid of the curves on diagram I., in combination with the curve giving the weight of iron necessary at the various inductions.

An example will best illustrate how this loss is ascertained in a

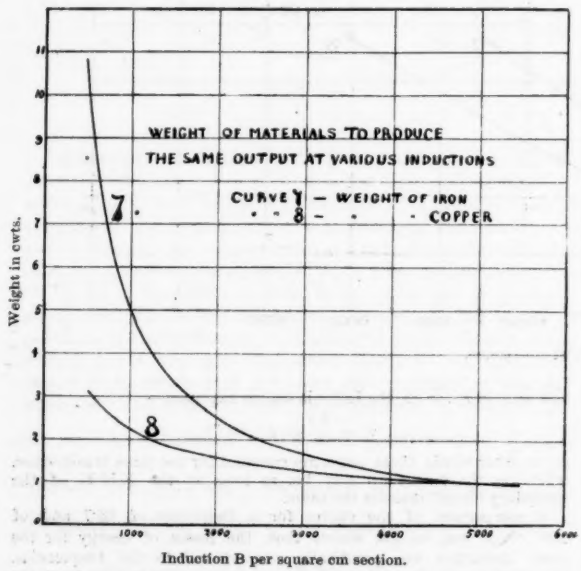
Loss by hyteresis only.—Curve 4, frequency = 100 ~ per second; curve 5, frequency = 66·72 ~ per second; curve 6, static hysteresis, according to Prof. Ewing.



If now, another transformer of the same series, but with a lower induction, is to produce the same voltage, the section of the iron has to be increased proportionately: for instance, in the case of B = 2,500 it has to be doubled.

The weight of the iron employed varies, in fact, inversely as the induction, and their relation can be represented by a rectangular hyperbola (curve 7).

As we have assumed that the thickness of the copper wire and the number of its turns are to be the same in all these transformers, the weight of the copper will vary directly with the length of wire wound



on the iron core, and this can be determined if the relationship between the length of periphery and the section of the iron core is known.

In the case of the sections of the cores being circles or squares or rectangles, with the same ratio between their length and width, the length of periphery varies as the square root of the section. As transformers are generally designed with cores of this kind, it may be accepted that the periphery of the iron core, and, consequently, the weight of copper to be employed, varies as the square root of the section of the iron core.

The weight of copper in the series of transformers under contemplation can therefore be represented by a curve (8) the ordinates of which are the square roots of the ordinates of the curve giving the weight of iron for the corresponding inductions. From these two curves it appears that the weight of the iron increases very rapidly with decreasing induction, while the weight of copper increases at a slower rate.

case where the total mass of the iron is worked at the same induction, produced by a current of a frequency equal to 100 ~ per second, the iron mass being composed of 1 mm. wires. The loss in the normal transformer working with an induction, B = 5,000, and with a weight of iron = 1 cwt., is 309·6 watts, according to diagram I. For another transformer working with an induction B = 2,500, the weight of iron, as shown by the curve (7), has to be increased to 2 cwt.; at the same time the loss per cwt. is reduced to 126·8 watts, or the total loss is reduced to 253·6 watts.

In a similar manner the losses for the different inductions have been calculated, and the results are embodied in a curve (9) which indicates that the loss of energy in the cores of transformers increases with the strength of induction, at first rapidly, but after the induction has reached a value of B = 1,000, the increase is very slow. As far as the loss of energy in the iron goes, it is, therefore, of not much consequence what induction between 1,000 and 5,000 lines per square cm. is used. The influence of the strength of induction on the loss of energy in the copper can be shown in the simplest manner by comparing this loss in the normal transformers designed for 5,000 lines with the loss in the other transformers of the series.

There are evidently three possible cases for the normal transformer: the loss in the copper may be equal to the loss in the iron, or it may be greater, or it may be less. For each of these cases a curve can be plotted, showing the sum of the losses in the iron and in the copper at the corresponding induction.

If we take, for instance, the case that the losses in copper and in iron are equal, the total loss in the transformer having an induction B = 5,000, is 2 × 309·6 watts.

For the transformer having an induction, B = 2,500, the loss in the iron is given in our curve 9, and the loss in the copper is in proportion to its weight, which varies in accordance with curve 8, or, in this particular case, the loss is = $\sqrt{2}$ × 309·6 watts. In this way curve 11 has been plotted for the case of the losses being equal, curve 10 represents the case where the loss in the copper is equal to two-thirds of the loss in the iron, and curve 12 where the loss in the copper is 50 per cent. greater than the loss in the iron.

Taking these curves to represent generally the variation of the total loss at the various inductions, it appears that, when keeping the loss in copper small in comparison with the loss in iron, it is quite possible to obtain about the same efficiency with any induction between 2,000 and 5,000 lines per square cm., but if a lower induction is used the efficiency, even on full load, decreases very rapidly.

From the consideration of efficiency it is, therefore, desirable to work the transformer with a high induction, and it is only the question of the heating of the apparatus which imposes restrictions on the use of high inductions, to avoid the destruction of the insulating material. In other words, the problem was to find the maximum internal temperature of a body of known dimensions, when the rate at which its mass is heated has been determined.

In order to obtain some data towards the solution of this problem, a solenoid was constructed by winding 18 lbs. of insulated iron wire, 2·4 mm. in diameter, on a brass tube 300 mm. long, 8 mm. internal diameter, and provided with flanges at the ends each 100 mm. diameter.

The internal temperature was measured by means of a thermometer just fitting the brass tube, and due care was taken to keep the temperature of the surrounding air constant during the experiments.

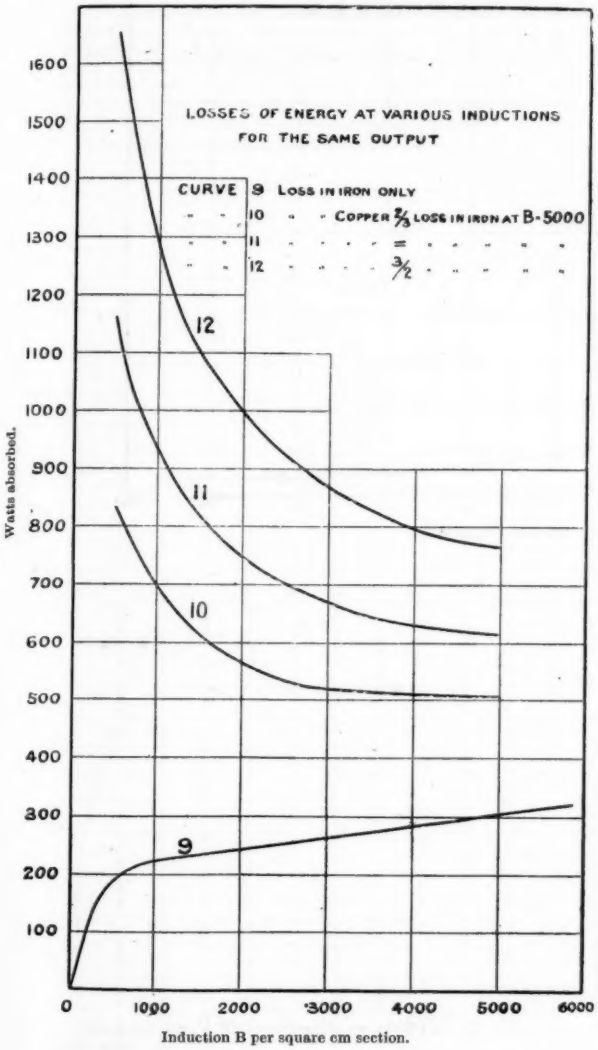
A constant direct current was sent through the coil, and a reading of the thermometer was taken after it had ceased rising. The rate

at which energy was supplied to the coil was determined by the product of the square of the current into the resistance of the coil, measured when the equilibrium of temperature had been attained.

By varying the current the internal temperature could be varied, and the results were plotted in curve 13, the abscissæ of which represent the cooling surface in square centimetres per watt dissipated, and the ordinates indicate the excess of the internal temperature of the coil over the temperature of the surrounding air in degrees centigrade, after the equilibrium between the supply and the dissipation of energy had been established in each case.

This curve is a rectangular hyperbola of the equation, $x\,y = 1{,}500$, and it shows that if the temperature of such a coil is to be kept at 100° C. the cooling surface should be 15 square cm. for each watt converted into heat in the coil.

It is self-evident that this curve (13) relates only to the coil by the aid of which it was constructed, and that it can only serve as a guide under strictly similar circumstances. By way of comparison a set of experiments were made on the same lines with a cable transformer, hung up in air, 6 metres long and 9·5 cm. in diameter, the internal temperature of which was determined by means of a test wire, as described above.



This curve (14) shows that for an internal temperature of 100° C. a cooling surface of about 28 square cm. has to be provided per watt of energy converted into heat in the transformer.

Before it is possible to draw general conclusions as to the connection between the internal temperature of transformers and their cooling surface, it is obviously necessary to make a good many more experiments in the direction indicated by the two curves just described.

Last year Dr. Fleming read a paper before this Institution "On some Effects of Alternating-Current Flow in Circuits having Capacity and Self-Induction" (*Journal of the Institution of Electrical Engineers*, vol. xx., No. 94, p. 374); it is, therefore, not necessary to repeat here the results of some experiments which were brought to the notice of the Institution at that time.

A very important factor in the construction of alternate-current apparatus is the striking distance of these currents in various materials, as this determines, in the case of high-voltage currents, the thickness of the insulating material with which the conductors have to be surrounded, the ohmic resistance being no guide.

The first set of these experiments referred to the striking distance in air. In all the experiments made the frequency of the alternate current was 100 ∿ per second, except where another frequency is specially mentioned, and the voltage was produced by means of an alternate-current machine and a transformer, and it was measured by one of Sir William Thomson's static voltmeters.

The electrodes were re-polished each time a spark had passed between them; one of them was fixed horizontally during the experiments, while the other could be advanced towards it from above by means of a micrometer screw which allowed of reading to a hundredth of a millimetre.

The experiments were made in the following manner:—After connecting the electrodes of the spark micrometer to the terminals of the transformer, a certain voltage was put on and accurately measured; the distance between the electrodes was then slowly diminished until sparking occurred. Each experiment was repeated at least three times. Various electrodes were experimented with, the first pair being two plane parallel surfaces. In this case the fixed horizontal electrode consisted of a polished brass disc, about 100 mm. in diameter, while the movable electrode was also formed by a brass disc, but only 37 mm. in diameter. To prevent the action of sharp edges, the edges of the discs were rounded off. The temperature of the surrounding air during these experiments was 14·75° C.

The results obtained are as follows:—

Difference of Potential.	Striking Distance.	Difference of Potential.	Striking Distance.
2,000 volts	0·67 mm.	10,000 volts	4·80 mm.
4,000 „	1·59 „	12,000 „	6·46 „
6,000 „	2·53 „	15,000 „	10·23 „
8,000 „	3·60 „		

The last reading, giving the striking distance for 15,000 volts, cannot be correct, as the sparks started from the upper edge of the smaller disc, and not from the nearest points between the two discs, the smaller disc being placed above the fixed one.

Curve 15 is the graphic representation of the above table.

For the next series the arrangements were the same as before, with the exception that the smaller movable disc was replaced by a half-sphere of 10 mm. diameter. The temperature of the air during these experiments was from 16° to 17° C., and its humidity 80 per cent.

Difference of Potential.	Striking Distance.	Difference of Potential.	Striking Distance.
2,000 volts	0·45 mm.	10,000 volts	4·37 mm.
4,000 „	1·40 „	12,000 „	5·65 „
6,000 „	2·30 „	14,000 „	7·32 „
8,000 „	3·25 „	15,000 „	9·02 „

These results are plotted in curve 16.

After this the movable electrode of the spark micrometer was replaced by a steel point of an angle of 60°, its section being an equilateral triangle of 5 mm. sides. This point was also re-polished after each spark; the spark, however, did not always start from the point. During these experiments the temperature of the air was 12° C., and its humidity about 50 per cent.

Difference of potential.	Striking distance.	Difference of potential.	Striking distance.
2,000 volts	0·40 mm.	10,000 volts	5·78 mm.
4,000 „	1·26 „	12,000 „	7·60 „
6,000 „	2·66 „	14,000 „	9·37 „
8,000 „	4·08 „	15,000 „	10·70 „

Curve 17 embodies this table.

After this the influence of an alteration in the frequency was tried by lowering this to 80 ∿ per second, and repeating some of the first experiments with disc electrodes. The striking distances for 4,000 volts and for 6,000 volts under these circumstances were found to be 1·47 mm. and 2·30 mm., or only slightly different from those produced by a frequency of 100 ∿ per second. From theoretical considerations it might have been expected that the distances would vary directly as the frequencies.

In order to investigate the influence of capacity, one or more coils of gutta-percha-covered wire were connected to the circuit of the transformer in parallel with the spark micrometer. The first experiments were made with a frequency of 100 ∿ per second, the two disc electrodes, and a capacity of 0·113 microfarads. The temperature of the air was 16·5° C., and its humidity 79 per cent.

Potential difference.	Sparking distance. With capacity.	Without capacity.
4,000 volts	1·53 mm.	1·59 mm.
6,000 „	2·21 „	2·53 „
10,000 „	4·17 „	4·50 „

A further experiment under similar conditions, but with a capacity of 0·28 microfarads in circuit, showed that the sparking distance at 10,000 volts was further reduced to 3·94 mm.

These tests were repeated with other electrodes, viz., the spherical surface and the disc.

At a difference of potential of 10,000 volts the sparking distance turned out to be:—

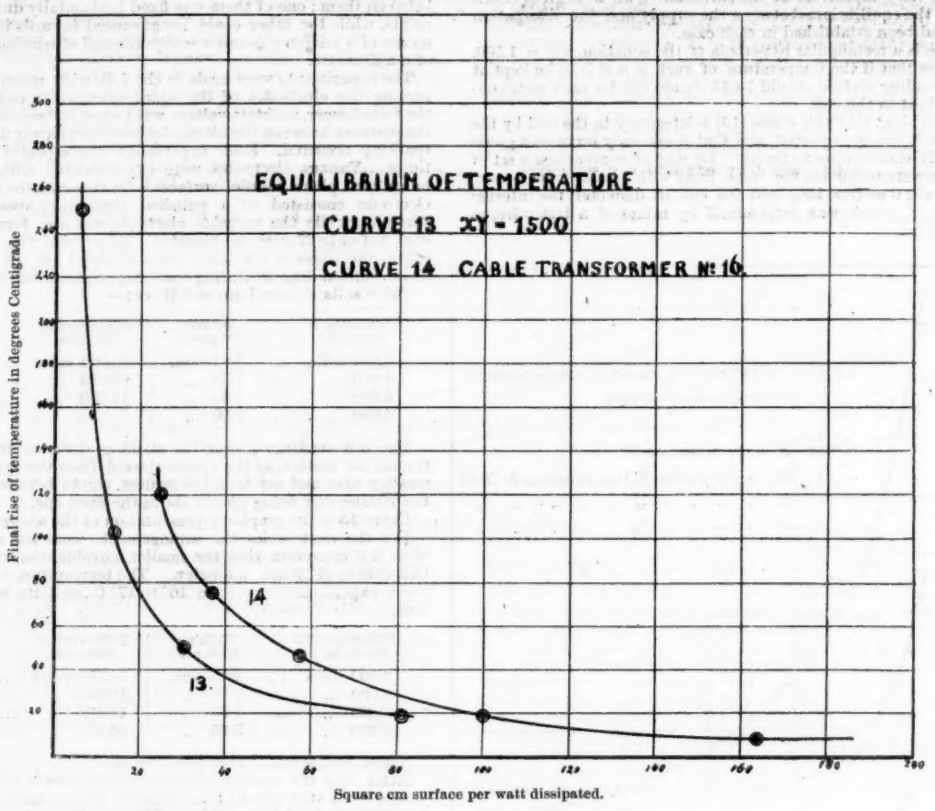
1. With 0·14 M.F. capacity in circuit ... 4·08 mm.
2. Without any „ „ ... 4·50 „
3. With 0·14 M.F. „ „ ... 4·06 „

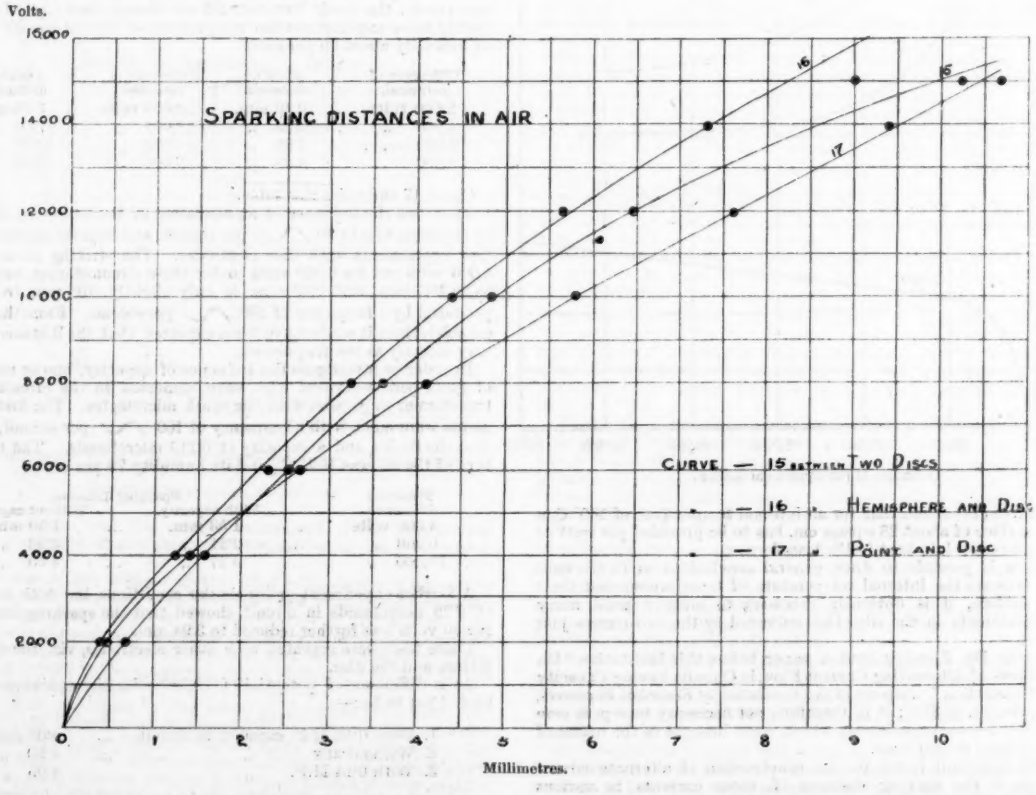
After that the steel point and the disc were used as electrodes, a capacity of 0·14 M.F. being connected to the circuit, and the results were:—

Difference of Potential.	Sparking Distance. Without.	With Capacity.
4,000 volts ...	1·26 mm. ...	1·14 mm.
10,000 „ ...	5·78 „ ...	4·83 „

All these experiments point to the fact that the sparking distances in air are diminished to a slight extent when capacity comes into play.

The experiments detailed above were made with the spark micrometer connected to the beginning of the cable; they were afterwards repeated after inserting the spark micrometer in the middle of the cable, and again after it had been connected to the end of the cable. In all three positions the same striking distance was observed under similar circumstances, which tends to prove that the voltage is propar


EQUILIBRIUM OF TEMPERATURE
CURVE 13 XY = 1500
CURVE 14 CABLE TRANSFORMER Nº 16.
Final rise of temperature in degrees Centigrade
14
13
Square cm surface per watt dissipated.



With a view of ascertaining how the voltage is propagated along a circuit, the position of the micrometer relatively to the cable was varied.

gated uniformly over the whole length of conductor, even if there is capacity in some parts of the circuit.

As stated above, the voltage experimented with was measured by

means of Sir William Thomson's static voltmeters; but it is undoubtedly the highest ordinate of the wave which causes the spark. This "real" voltage can be found, if sine waves are assumed, by multiplying the measured volts by $\sqrt{2}$, and these new figures should be applicable to constant continuous currents.

In this way the results of curve 15 were corrected, and compared with some results published by Warren de la Rue in *Nature* on the 12th September, 1878. Assuming that the E.M.F. of his cells was equal to 1·03 volts, and reducing his results to volts and millimetres, they compare as follows:—

Difference of Potential.	Striking Distance.	
	Warren de la Rue.	Siemens.
2,000 volts	0·45 mm.	0·25 mm.
4,000 „	0·95 „	0·80 „
6,000 „	1·55 „	1·45 „
8,000 „	2·15 „	2·15 „
10,000 „	2·85 „	2·85 „

On referring to the other curves published at the same time, it will be seen that Warren de la Rue found the sparking distances between two plain surfaces and between two spherical surfaces not to differ very much from each other. It may, therefore, be allowable to compare the mean values of these two curves of his with curve 16 for the sparking distance between a hemisphere and a plain surface after the values of the volts have been multiplied with $\sqrt{2}$.

connecting the terminals of the transformer to the inner and outer conductor of concentric cables, the insulation of which consisted of impregnated fibrous material. The difference of potential was then gradually and slowly raised until the insulation gave way.

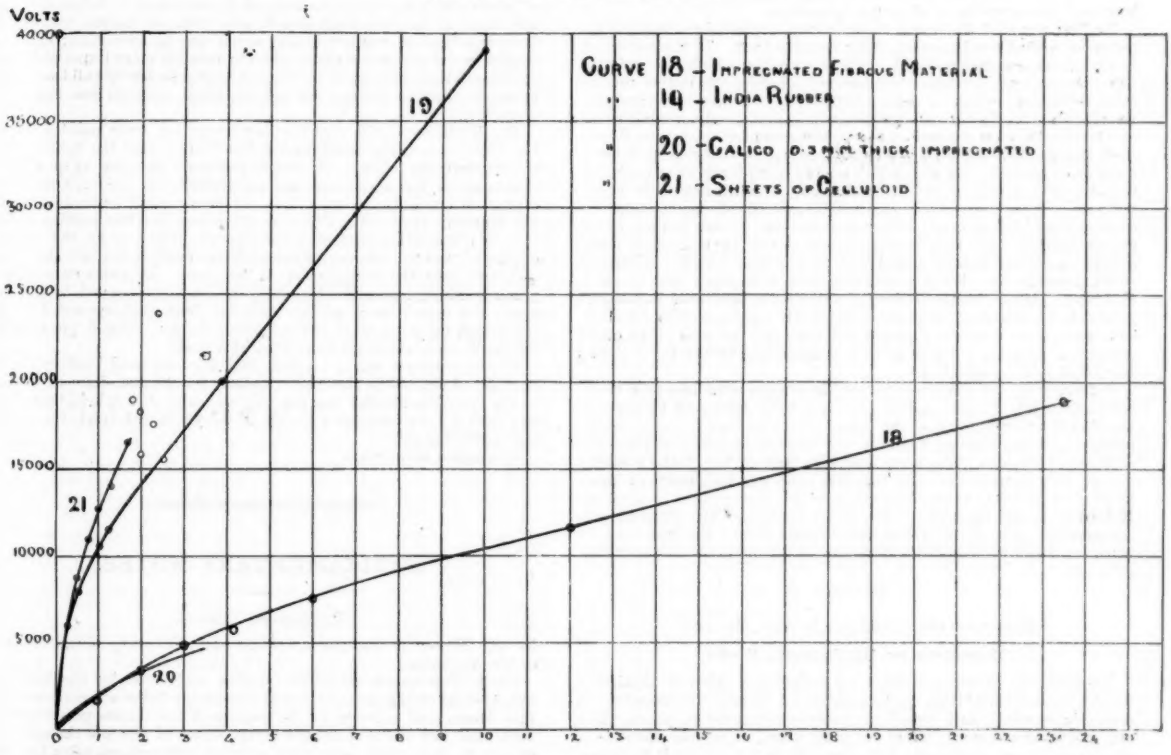
Curve 18 really consists of two parts, the lower of which was obtained by breaking 35 short samples of cable, made with various thicknesses of the insulating material; the upper part, above 7,000 volts, was determined by breaking actual cables, not less than 50 yards in length, specially manufactured for these experiments.

The next series of experiments dealt with India-rubber insulation, but results proved to be extremely irregular, although a curve (19) has been plotted which gives the minimum voltage at which sparking occurred at the various thicknesses.

The following table gives the details of the samples tested, and under what voltage they broke down:—

No.	Thickness of India-rubber.	
1. 40 in. of 880 H wire ...	3·5 mm.	broke with 21,500 volts.
2. 10 yds. of experimental core	3·8 mm.	„ „ 20,000 „
3. 1½ „ „ „	2·5 mm.	„ „ 16,000 „
4. 1 „ concentric cable	3·5 mm.	„ „ 28,000 „
5. 90 „ No. 504 core ...	1·2 mm.	„ „ 12,000 „
6. 46 „ „ 505 „ ...	2·0 mm.	„ „ 16,500 „
7. 50 „ „ 507 „ ...	1·8 mm.	„ „ 18,200 „
8. 48 „ „ 508 „ ...	2·3 mm.	„ „ 16,800 „
9. 5 „ „ 200 H wire...	2·3 mm.	„ „ 28,000 „
10. 1 „ concentric cable	2·0 mm.	„ „ 17,500 „
11. India-rubber sheet	0·5 mm.	„ „ 7,500 „
12. „ „	1·0 mm.	„ „ 10,500 „
13. Experimental piece of core	10·0 mm.	„ „ 38,000 „

Sparking distances in insulating materials.



Millimetres.

Difference of Potential.	Striking Distance.	
	Warren de la Rue.	Siemens.
2,000 volts	0·36 mm.	0·25 mm.
4,000 „	0·87 „	0·80 „
6,000 „	1·50 „	1·45 „
8,000 „	2·10 „	2·16 „
10,000 „	2·75 „	2·85 „

Both these tables show that the results are practically identical, and consequently it may be concluded that the secondary current of the transformer used for the experiments is really a sine function.

Some further experiments were made with the same alternate-current machine and transformer, and a frequency of 100 $\sim$ per second, to determine the striking distance in various insulating materials. The differences of potential were again measured by Sir William Thomson's static voltmeter, or, in the case of the higher ones, by his volt balance.

One series of experiments, represented by curve 18, was made by

The concentric cables were tested by connecting the transformer to the two conductors; the sheets were placed between the disc and the spherical electrode. The core, when in short lengths, was covered with tinfoil; when long, it was immersed in water; and the terminals of the transformer were connected, the one to the insulated conductor, the other to the water or the tinfoil respectively.

Another set of tests were made by placing calico on the disc of the spark micrometer, and by connecting the other pole to a copper brush, such as are used in dynamo machines, resting on the calico.

Several samples of calico were tried—

(*a*) Thin calico, 0·12 mm. thick, not impregnated.
(*b*) Silesia calico, 0·15 mm. thick, not impregnated.
(*c*) Thick calico, 0·30 mm. thick, not impregnated.
(*d*) Thick calico, 0·30 mm. thick, impregnated.

All four samples required the same lowest difference of potential—about 700 volts—for a breakdown. Different spots of the same sheet behaved very differently, some not breaking with even 1,000 volts; but at least one spot could always be found which broke down with 700 volts.

Curve 20 gives the results obtained with several layers of the impregnated thick calico. The layers were tightly pressed together before being tested, and the points of the curve give the minimum value of the voltage which broke them down.

The last curve (21) records the sparking distance through celluloid, which was tested in sheets placed between the two discs of the spark micrometer.

A good many of the high-tension experiments were made with a specially constructed powerful transformer, capable of giving at its secondary terminals a current of 2 ampères under a pressure of about 50,000 volts. This is now on view at the Crystal Palace Electrical Exhibition, and various experiments are shown to exhibit its qualities. Unfortunately, it is too heavy to be shown in this Institution.

In conclusion, it should be mentioned that all the experiments described in this communication were carried out at Woolwich, at the works of Messrs. Siemens Brothers & Co., mostly under the immediate care of Dr. Baur, who was freely assisted by the heads of the various departments whenever he encountered difficulties in the course of his work.

Discussion.

(Authorised Abstract.)

The President requested that before the discussion was commenced, questions should be asked on any points of Mr. Siemens's paper on which further information was desired.

Mr. Swinburne wished to know how long the E.M.F. was applied when determining the sparking distance and whether when measuring in air the electrodes were steadily brought nearer till the spark passed.

A Member asked what rubber was tested, whether vulcanised or not.

Mr. Trotter asked how the thickness of the insulation in the concentric cables was measured.

Prof. Forbes suggested that any discussion on Mr. Siemens's paper should be postponed till the next meeting when the members would have had the opportunity of seeing it in print.

Mr. Preece said that some time having elapsed since reading his paper he wished to add some further remarks to it. In the matter of India-rubber insulation, durability was a quality which was quite as important as high insulation resistance. Though the initial insulation resistance might be very high, it by no means necessarily remained so; in fact he always rather mistrusted rubber which had an abnormally high insulation, and in the case of gutta-percha it was well known that high resistance was generally accompanied by a want of durability. At the G.P.O. rubber was tested by exposing it to a dry heat, 270° F. for 1 hour, and then to a moist heat, 320° F. for 3 hours. A rubber which stood this test could, he thought, be depended on to last some 15 years in a cable, if not heated by an excess current. He had arranged that at the next meeting there should be exhibited some samples of rubber thus tested. Referring to oil insulation he wished to call attention to a paper read by Prof. Hughes in 1854 before the Society of Arts on "A Semi-fluid Insulator," in which he proposes to cover a cable with gutta-percha or other substance, draw it into a pipe and fill the latter up with oil or other semi-fluid, pointing out that if the insulation was broken down it was immediately re-established.

Referring to Mr. Siemens's paper Mr. Preece remarked that these tests were all on new cables, and must be taken as giving the limiting pressures they could bear under the best conditions; in practice it was necessary to allow for fissures in the insulation, the surfaces of the wire being dirty and the edges of the cracks possibly damp. He thought therefore that 500 volts per millimetre of insulation was probably as much as could be safely permitted in practice. Referring to the closeness between the results of Mr. Siemens and the previous ones of Mr. De la Rue he said it was the first time he had ever found two experimenters who could agree about a sparking distance.

February 28th, 1892 (*Authorised Abstract*).

Discussion on Mr. Preece's Paper.

Mr. Stewart Russell denied any connection between insulation resistance and durability, quoting cables of 14 and 0·6 Preece units respectively which had lasted perfectly constant for 4½ years, while one of 3·8 came down to ·35 in the same time. Sparking distance in air was also quite irrelevant; for a good cable the air spark thickness was far greater than necessary and for a cracked cable very much too small. Mr. Preece quoted the B.T. rules but it was well-known that these quite ignored quality and their natural result was the use of thick bad quality insulation which would not last. The speaker then quoted some tests showing that the E.M.F. to break a cable down did not vary directly with the specific resistance; also some on the effect of time in breaking down tests. From these he showed that a high pressure does not permanently alter the insulation of a cable unless there is an incipient fault. As a practical test he would measure the insulation resistance of a cable, then subject it for some time to three times its working pressure, and pass it if the insulation remained the same afterwards.

Mr. Swinburne said sparking distance in air had nothing to do with anything. In large wires the insulation was subject to approximately an even strain throughout its thickness, but in the case of a small wire the strain might be very uneven, being much greater, close to the wire, then at the outside. If anything, therefore, a small wire should have a thicker covering than a large one. When testing a long cable at high volts the "condenser current" became large, necessitating a large dynamo; but this could be overcome by putting a big choking coil in series with the cable.

Mr. Esson would allow 2 per cent. drop instead of 1 per cent. in the leads, as in Mr. Preece's specification, as only one half of the lamps would be on at once. He would also add a clause that the current should never exceed 1,000 A. per square inch.

Mr. Mavor instanced the case of a large order for a cable which had been made with the utmost exactness to the specification based on experiments of the engineer who ordered it, and which failed completely. He objected to men without practical experience in cable manufacture specifying the thickness, &c., of insulation.

Discussion on Mr. Siemens's Paper.

Mr. Siemens, in answer to the preliminary questions asked at the last meeting said, with regard to the time in the breakdown tests, half the estimated breaking pressure was first applied and then raised step by step; each rise taking some 2½ minutes, and then being left on never less than one quarter of an hour, often hours or days before again raising. Time made no difference in air spark experiments. The vulcanised rubber tested was the same as that used for insulating cables; the thickness of concentric cable insulation was measured from the outside of the inner conductor to the inside of the outer. He considered that the way of manufacture had more to do with resisting sparking through than the actual material used.

Prof. Perry welcomed Mr. Siemens's paper as giving actual values in transformer work, which were much wanted. He would, however, like to have much fuller details, so as to know what weight to give to the results. He rather doubted the method of measuring temperature, 1° rise meant a variation of ·002$^{\omega}$ in 1·3$^{\omega}$; and if the battery was not reversed, thermo-electric forces might exist quite commensurate in effect with this small change of R.

Dr. Fleming objected to Mr. Siemens calculation of the eddy currents, which he said were all 20 per cent. too low; consequently the hysteresis loss, which was got by deducting the eddy current loss from the total loss, which was too large. Mr. Siemens results when corrected made the hysteresis loss exactly proportional to the induction. The loss being $\cdot 625 \times n \times B \times 10^{-7}$ watts per cc. In the eddy current loss the temperature of the core must be taken into consideration as the loss decreased ·6 per cent. per degree rise. With fine wires the loss was practically solely due to hysteresis; but with large wires or plates the eddy currents were far more important. He considered that the alleged decrease of hysteresis loss at full load might be due to the iron getting hot and the eddy currents less than were calculated.

Mr. Evershed said that the last source of error pointed out by Dr. Fleming roughly counteracted the first, so that the figures given were practically right. He much preferred the use of a clinical thermometer for measuring the temperature of the core, and considered it less liable to error than resistance measurement methods. Mr. Siemens apparently made no allowance for the heating of the core by the exciting current in the copper. The way he, the speaker, employed was to pass an equivalent direct current through the windings and note the temperature of the core. In some experiments made by himself and Mr. Vignoles, the heating observed by thermometer had been some 6 per cent. greater than that accounted for by calculated eddy currents, static hysteresis, &c. This 6 per cent. he felt inclined to attribute to viscous hysteresis.

Mr. Swinburne did not think that the increased heating due to increase of current in the copper caused the alleged decrease of loss in the iron, Mr. Mordey was the only one who still upheld that there was such a diminution, and in Mr. Mordey's transformer the copper was inside the iron.

Discussion adjourned.

PARLIAMENTARY NOTES.

Telegraph Clerks.

In the House of Commons on Thursday, February 25th, in answer to Mr. McCartan,

Sir J. Fergusson said: The duties performed by the first and second-class clerks in the Central Telegraph Office are not identical. The distinction consists in the quality of the duties prescribed for each class, and as the allotment of the scales of pay and the numbers proper to each class have very recently been settled, after full and careful consideration, the difference in the salaries is considered to be fully warranted. The "maximum" of the second-class, and the "minimum" of the first class are identical—£110 a year. It is not usual to have regard to precedent, and, indeed, it is impossible to prevent one deserving officer from being more fortunate than another in obtaining promotion.

The Cost of Telegraphic Lines to the Continent.

In the House of Commons on Friday, in answer to Mr. Henniker Heaton,

Sir J. Fergusson said: An account could be made of the receipts derived from foreign messages, but some part of them would be applicable to Inland service. The expenditure would be more difficult to define accurately, as the staff is largely employed also on Inland duties. It would be impossible to give the total cost to Her Majesty's government of the acquisition of the submarine lines, inasmuch as the Dutch lines were not distinguished in the purchase of the whole system of the Electric and International Telegraph Company.

Cable Companies.

In reply to Mr. Henniker Heaton,

Sir J. Fergusson said: The cable companies pay £5 a mile a year for the telegraph wires over which they transmit their messages in this country. For messages handed in at postal telegraph offices to be forwarded by cable, or for messages arriving by cable and

transmitted by our wires, the department charges the ordinary inland rate of ½d. a word. I have not ascertained the total amount of words received by cable in this country from, and despatched to, the countries named, and I have no means of doing so.

THE TELEPHONE SERVICE.

Last Friday Dr. CAMERON asked the Postmaster-General whether he was yet in a position to announce the decision of his Department on a question stated by his predecessor to have been under consideration at the beginning of last Session—namely, the granting of licences for telephone exchanges to applicants proposing to introduce loud speaking and other improved forms of telephone which have become available through the expiration of the principal telephone patents in July last.

Sir J. FERGUSSON replied that the hon. member's question was connected with one of much wider scope, and one that was at this moment under consideration, Speaking generally in regard to the granting of additional telephone licences, each application must be considered on its own individual merits.

TELEGRAPHIC MONEY ORDERS.

In the House of Commons on Monday last,

Mr. HENNIKER HEATON asked the Postmaster-General whether he would consider the advisability of simplifying the system of telegraphic money orders, and the form of such orders; whether he could see his way to a reduction of the charge for such orders; and whether he would direct that the money should be delivered at the residence of the person to whom the telegraph money order was payable, with a view to ensure speed and to guard against mistake or fraud.

Sir J. FERGUSSON: It is not thought that the system can at present be made more simple. It follows that of postal money orders. It will be extended on March 1st to all offices open both for money orders and telegraphs, and the instructions have been revised. A certain reduction of charge will then take place, namely, when one remitter sends more than one order at the same time to one recipient up to £50, only one telegram of advice will be required. It is not thought expedient to alter the rule by which the recipient must claim the money at the paying office, which affords the security against fraud. The limited experiment hitherto made has shown an increasing popularity and few complaints, the number of telegraphic money orders having reached 10,673 in the last quarter, as compared with 7,409 in the corresponding quarter of last year.

RAILWAY COMPANIES' TELEGRAMS.

In answer to Mr. Thos. Ellis,

Sir J. FERGUSSON said: The number of telegrams sent free by the Post Office on account of the railway companies in the years 1888 to 1891, respectively, is as follows:—1888, 1,033,433; 1889, 1,196,596; 1890, 1,406,398; 1891, 1,571,803. The above figures refer to the telegrams sent free on behalf of railway companies only, that being the information asked for. But it is right that I should state for your information that several canal companies also possess the right to send free telegrams, and that some railway companies—notably, the Irish railway companies—have the privilege of sending telegrams at a reduced rate.

ELECTRIC AND CABLE RAILWAY SCHEMES.

In the House of Commons last Tuesday Mr. WHITMORE moved: "That a Joint Committee of Lords and Commons be appointed to consider the best method of dealing with the electric and cable railway schemes proposed to be sanctioned within the limits of the metropolis by Bills introduced, or to be introduced, in the present session, and to report their opinion as to whether underground railways worked by electricity or cable traction are calculated to afford sufficient accommodation for the present and probable future traffic; as to whether any and which of the schemes proposed satisfactory lines of route; as to the terms and conditions under which the subsoil should be appropriated; whether any and, if any, what schemes should not be proceeded with during the present session; that a message be sent to the Lords to communicate this resolution, and desire their concurrence." He urged, in support of the motion, that the proposal was supported by the corporation and the County Council of London. He justified his proposal for the creation of an unusual tribunal by pointing out that electric and cable schemes were very numerous and very important, and that it would be well for the future comfort and convenience of London if, at the outset, an authoritative enquiry by such a joint committee as he suggested took place instead of referring Bills to different committees.

Mr. T. H. BOLTON, in rising to second the resolution, said that he believed the reference would cover all the important questions which might arise in connection with these railways.

Mr. KIMBER moved, as an amendment, to add the words, "Provided that such committee, before reporting that any schemes for which Bills have been deposited should not be proceeded with, shall have first heard the parties promoting such Bills, and, if desired by them, receive evidence thereon."

Mr. COURTNEY thought that the present would not be a convenient time to move the amendment, and suggested that it should be withdrawn.

The amendment was then by leave withdrawn.

Mr. ISAACS, while entirely concurring in the resolution, hoped that the committee would lay down some condition by which promoters of any of these schemes would not be allowed to interfere with the metropolitan lines.

The resolution was agreed to.

TORPEDO VESSELS.

Mr. GOURLEY asked the First Lord of the Admiralty whether he had, or whether he intended organising in detail, a plan of campaign for the various types of ships comprising the squadrons of the Navy; if so, had he considered the part likely to be demanded of vessels of the torpedo class; whether he was aware that foreign maritime Powers attached more importance to this description of naval warfare than the British Admiralty, the French Minister of Marine having provided France with 184, and the Italian Minister of Marine, Italy, with 123 torpedo vessels, as against 85 now in the British Navy; and whether the vessels now building were being fitted with 14-inch, 16-inch, or 18-inch torpedoes.

Lord G. HAMILTON: The subject mentioned in the first sentence of the question has received all the attention which its importance deserves, and the employment of all classes of ships likely to be used in war has not been omitted from the consideration of the Admiralty. We have no reason to suppose that any foreign naval Power attaches more importance than we do to any description of naval warfare; but it is quite likely that Continental Powers are alive to the policy of employing the methods best adapted to their own peculiar circumstances, instead of copying those suited to other countries of which the maritime conditions are different.

SECOND-CLASS CLERKS AND FIRST-CLASS DUTIES.

In answer to Mr. M'Cartan,

Sir J. FERGUSSON said: 1. Second-class telegraphists, who, owing to the exigencies of the service may be temporarily employed upon first class duties, are undoubtedly qualifying themselves for promotion to the superior class when vacancies occur. 2. Without such opportunity for acquiring the necessary qualification they of course could not be promoted, and when promotion is obtained, this in itself affords sufficient compensation for any temporary discharge of higher duties. This is the universal rule of the service, and I should think of all other services, and there is no ground whatever for altering it. 3. The distinction between the first and second class duties is generally well understood, but there may be cases, of course, in which the one very nearly approaches the other. 4. It is not the practice of the service in any case to make promotion retrospective beyond the date of the vacancy.

NOTES.

High Speed Electric Traction.—It is reported that M. Bonneau, sub-traffic manager of the Chemin de fer de Paris-Lyon et de la Méditerranée and M. E. Desroziers, have investigated the subject of electricity as the motive power on ordinary railways. The locomotive proposed weighs 35 tons and would develop at a speed of 77½ miles an hour, a power of 1,250 horse-power! Two motors would be used, one being arranged on each of the axles. We wonder if these gentlemen are sure of their figures? We doubt it.

L'Industrie Electrique.—Our French contemporary is preparing a complete list of the central stations in France for the distribution of electric energy; and will also include a plan of Paris showing the situations of the most important electric installations.

St. Pancras Vestry Electric Lighting Bill.—The *Daily Oracle* states that the St. Pancras Vestry have given notice of the withdrawal of their deposited bill, under which powers were sought to borrow £360,000 for the electric lighting of the whole of the parish.

Kingswood Electric Lighting.—Referring to our note on this subject in our last issue, we notice a letter in the *Western Daily Press* stating that the whole district from Hanham Road to Warmley was not lighted by electricity, and that there were only six lights and these were situated in Regent Street.

The Electric Lighting of Preston.—The National Electric Lighting Company, which for about a year has supplied electricity in the main streets of Preston by means of experimental overhead wires, are replacing them by wires laid in tubes under the footpath.

Personal.—We hear that Major Flood Page has been elected a director of the Edison and Swan United Electric Light Company, Limited, in the vacancy caused by the death of the late Mr. Leyland; he was also elected deputy-chairman.

O.S.A.—A meeting will be held the Central Institution on Friday, March 11th, when Messrs. H. B. and W. Fox Bourne will read a paper on "The Behaviour of Insulating Materials under the Action of High Potential Differences," illustrated by experiments with a transformer giving 50,000 volts.

Breakdown of the Lerwick Telegraph Cable.—The Aberdeen and Lerwick telegraph cable has again given way somewhere between Ackergil Bay and Shetland, which will prevent any telegraphic communication between the mainland and the Shetland Islands. The accident will occasion great inconvenience, as the only way in which communication can now be kept up with Shetland is by the steamers from Aberdeen or Kirkwall.

Theatre Lighting.—The Birmingham Grand Theatre was lighted last week by electricity, and the installation was complete and satisfactory. The current is supplied by the Birmingham Electric Supply Company. The work of fitting up the theatre has been carried out by Fowler, Lancaster and Co., Limited, under the personal superintendence of Mr. Lancaster.

Automatic Postal Call-box.—A very ingenious automatic machine has been established near the letter box at Charing Cross Station for the collection of letters to be forwarded by the Post Office Express Service. It is in electrical connection with the Postal Telegraph Office opposite the station. By dropping a penny into the slot, and pulling out the slide, a brown-coloured envelope is delivered. This envelope contains another envelope and a card. The communication is intended to be written on the card, which is then enclosed in the white envelope, and this, with the fees for delivery, which have been fixed at threepence per mile, is re-enclosed in the outer envelope, and deposited in the box behind the flap, which bears the printed instructions. The act of withdrawing the slide sends the call signal to the telegraph office, and a messenger is at once dispatched to collect the special letters.

The First and True Inventor.—We notice that Sir Henry Mance patented only 15 months ago "An improvement in electrical transformers," in which his only claim is for a casing containing an insulating fluid in which the transformer induction coils are permanently immersed. We would refer him to the leaderette on p. 283 dealing with this subject; also to Mr. Preece's remarks on p. 292.

Proposed Electric Lighting of Woollen Mills.—It is stated that the Welsh Manufacturing and Wool Sampling Company, Limited, contemplate introducing the electric light into their mills and warehouses at Llanidloes and Glanghywedog.

The Electric Light in the West of England.—The Teignmouth Local Board had under consideration on Monday a scheme for introducing the electric light. After discussion the further consideration of the matter was deferred.

Proposed Cable to Japan.—According to the *Financial Times*, Mr. R. Hosmer, President of the Canadian Pacific Railway Telegraph Company, says that the company is desirous of having a cable laid between Vancouver and Japan, as the present cable rates to Japan from Canada are almost prohibitory. The cost of such a cable would be between four and five million dollars, the best route being *viâ* the Aleutian Islands.

Electric Lighting at Worcester.—At a meeting of the Worcester Watch Committee held last Friday, it was reported that fifteen tenders had been received for the supply of electric light under the provisions of the Council's order, and Mr. W. H. Preece, F.R.S., was engaged to advise the Council on the tenders.

The Burnley Town Council and Electric Lighting.—At a meeting of the Gas Committee of the Burnley Town Council, held last Thursday week, it was resolved that steps be taken to carry out the provisional order for electric lighting. They also recommended the Town Council to apply to the Local Government Board for sanction to borrow £25,000 for such purposes, the borough surveyor to prepare in the meanwhile plans and estimates for the erection of an electric lighting station.

Electric Lighting at St. Helens.—The Local Government Board have written to the St. Helens Corporation sanctioning the borrowing of £1,700 for the ventilation and electric lighting of the St. Helens Town Hall and municipal offices. The engines are expected to be only a temporary arrangement until such time as the Corporation determine to light the whole of the town with electricity.

The Electric Lighting at Cardiff.—An electric light installation has just been completed at Cardiff, where Messrs. Hopkins's new pile of buildings has been illuminated from basement to roof. The installation was carried out by Messrs. Gilbert & Co., of Hanway Street, London, W.

The New Pacific Cable.—We understand that the Queensland Government has accepted the proposals to construct the first section, from Gladstone to New Caledonia, of the Pacific cable, subject to the approval of the scheme by the New South Wales Government. A Reuter's telegram from Sydney dated 29th inst., states that the New South Wales Government is willing to subsidise the section of the Pacific telegraph cable between Queensland and New Caledonia, on condition that Government messages shall be transmitted free.

Institution of Electrical Engineers.—A students' meeting was held at the Library of the Institution on Friday, 26th ult., Mr. W. B. Esson presiding. Mr. C. Wharton read a paper on "House-wiring." At the next meeting, on the 11th inst., two short papers will be read on "Electrometers," by Mr. McDonall, and on "Electric Welding," by Messrs. M. S. Poore and C. V. Drysdale. On Thursday, March 10th, there will be an ordinary general meeting at 8 p.m., when the discussion on "Some Experimental Investigations of Alternate Currents," by Alexander Siemens, Vice-President, will be continued. There will also be a paper, illustrated by experiments, on "Oil as an Insulator," by Prof. Hughes, F.R.S., Past-President.

Private Telephones.—A correspondent has written to the *Engineer* asking whether the Post Office authorities have the sole right of putting up telephone lines and instruments, and whether anyone is at liberty to put up such lines, &c., without consulting the Post Office officials. Our contemporary has replied to this enquiry thus:—"Persons or firms are at liberty to erect lines of private wire, and supply instruments from one part of their property to another, or between two places of business belonging to the same person or firm, providing the communications are for their own use only, and not for let or hire. It is an infringment of the Postmaster-General's monopoly to provide lines between separate persons or firms without a licence from the Postmaster-General. The Postmaster-General cannot erect wires across private property without the consent of the owners, nor can he erect lines on public roads without the consent of the body controlling such roads. Therefore he has no special powers to prevent others from doing so, always supposing his monopoly as to communications is not infringed."

Resistance Alloys.—Every now and again, says *Industries*, a new alloy is brought out for the use of electricians, and is claimed that the temperature coefficient is low, and the specific resistance abnormally high. Low temperature coefficients are valuable, but high specific resistance, which is nearly always claimed as a great advantage, is really a serious evil. For use in resistance boxes the specific resistance is of little importance, as the cost of the wire itself is a small fraction of that of the bridge, and fine wire can be used for the high resistances. Of course, for such resistances as a megohm high specific resistance is important, as the fineness of the wire is limited by mechanical considerations. Resistances, however, take a very small portion of the wire now used. Voltmeters and similar instruments require wire with the highest possible conductivity combined with a low temperature coefficient. Here the cost of wire is serious, and the space is very limited. Inventors should therefore turn their attention to low resistance, not to high resistance alloys.

Waterford City Electric Lighting.—It has been decided to recommend the Board of Trade to grant the provisional order to the Corporation only and to reject the application of Messrs. Laing, Wharton and Down.

NEW COMPANIES REGISTERED.

Electrical Plant, Limited.—Capital £10,000 in £10 shares. Objects: To acquire, take over as a going concern, and carry on in all or any of its branches the business of proprietors and publishers of the monthly periodical known as *Electrical Plant*, now carried on at 52, Queen Victoria Street, E.C., by Henry Sherley Price and Wallace Rivers Goulty, and with a view thereto to enter into an agreement with the said H. S. Price and W. R. Goulty. Signatories: H. Sherley Price, 52, Queen Victoria Street, E.C., 246 shares; W. R. Goulty, Albert Chambers, Albert Square, Manchester, 246 shares; E. R. Dolby, 8, Princes Street, Westminster, 5 shares; S. S. Price, Jun., 52, Queen Victoria Street, E.C., 1 share; M. Belsham, 52, Queen Victoria Street, E.C., 1 share; W. H. Goulty, 63, Brown Street, Manchester, 1 share; H. C. Hall, "Eversley," Elmfield Road, Bromley, Kent, 75 shares. The number of directors is not to be less than three nor more than seven, the first being H. S. Price, W. R. Goulty and H. C. Hall. Qualification £250. Remuneration, one guinea for each attendance at a board meeting. Registered on the 27th ult. by Crouch, Edwards and Heran, 70, Basinghall Street, E.C.

"Eston" Arc Lamp Syndicate, Limited,—Capital £25,000, in £5 shares. Objects: To carry on the business of an electric lighting company in all its branches, electricians, electrical and mechanical engineers and electrical apparatus manufacturers; to acquire patents, inventions, licences, &c., and particularly the patented inventions for an arc lamp called the "Eston" arc lamp. Signatories (with 1 share each), A Essinger, 19, Clifton Hill, St. John's Wood, N.W.; T. Sturgeon, Alexandra Crescent, Ilkley, Yorks; J. A. White, 38, Holborn Viaduct, E.C.; F. E. Pearl, 27, Ivanhoe Road, Denmark Park, S.E.; M. I. Alexander, 68, Carlton Hill, N.W.; W. W. Westcott, 396, Camden Road, N.; E. J. de Buriattee, 38, Holborn Viaduct, E.C. The number of directors is not to be less than three nor more than six, the first being W. W. Westcott, M.B.Lond., D.P.H., G. North, M.I.M.E., A.M.I E.E., J. A. White, and A. Essinger. Qualification (except first directors), 20 shares. Remuneration, two guineas each for each board meeting attended, and £50 for each director extra for each 10 per cent. in the dividend above 10 per cent. Registered on the 26th ult. by H. W. Christmas, 42A, Bloomsbury Square, W.C.

Pioneer Telephone Company, Limited.—Capital: £100,000 in £10 shares. Objects: To procure the general establishment and development of telephonic means of communication, and to diminish the cost thereof, and to procure the adoption of improvements therein; to negotiate for and acquire, provisionally or otherwise, lands, buildings, contracts, patents, &c., and to promote the floating of a telephone company, or companies, with ample capital and resources, and to make over to such company all, or any, of the premises so acquired; to carry on the business of a telephone company, and to transmit and facilitate the transmission of messages. The signatories (with 1 share each) are: M. B. Praed, 189, Fleet Street, E.C.; Duke of Marlborough, 3, Carlton House Terrace, S.W.; J. B. Braithwaite, jun., 18, Highbury New Park, N.; F. W. Reynolds, Bromley, Kent; G. Herring, 1, Hamilton Place, W.; C. Braithwaite, 10, Lyndhurst Road, Hampstead; J. C. Bull, Broughton Lodge, Surbiton. The number of directors is not to be less than two nor more than ten, the first being the Duke of Marlborough, Colonel the Honourable Oliver Montague, Charles Praed, Esq., and F. E. Savory, Esq. Qualification, £250; remuneration as the company in general meeting determine. Registered on the 26th ult. by Dawes and Sons, 9, Angel Court, E.C.

Thompson, Ritchie and Company, Limited.—Capital £5,000 divided into 200 preference and 300 ordinary shares of £10 each. Objects: To acquire and carry on the business of electrical engineers, as now carried on by Arthur Stanley Grove, under the style of Thompson, Ritchie & Co., at 34, Victoria Street, Westminster, S.W., and with a view thereto to enter into the agreement with A. S. Grove, referred to in clause 2 of the articles, signatories (with one share each, except one): A. S. Grove, 34, Victoria Street, S.W., electrical engineer; J. C. Waltham, 34, Victoria Street, S.W., electrical engineer (100 preference and 65 ordinary shares); G. E. Lake, 10, Lincoln's Inn, W.C.; E. Waltham, 45, Christchurch Road, Streatham; A. S. Giles, 34, Victoria Street, S.W., electrical engineer; W. Daniel, 55, Chancery Lane, W.C.; C. H. Hurst, 14, Aytoun Road, Stockwell. The number of directors is not to be less than two nor more than four, the first being A. S. Grove and J. C. Waltham. Qualification, 50 ordinary shares. Remuneration £600 per annum, divided between them. Registered on the 22nd ult. by Lake, Beaumont and Lake, 10, Lincoln's Inn, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Mulholland, Maugham and Company, Limited (contractors for the laying of cables, wires, &c., for electric lighting and mechanical, electrical and general engineers).—The first annual return of this company, made up to November 5th, 1891, was filed on the following day. The nominal capital is £5,000, divided into 120 founders' and 380 ordinary shares of £10 each. All the founders' and 107 of the ordinary shares have been taken up. The full amount per share has been called on the founders', and £5 per share on the ordinary shares, and all calls have been paid. Registered office, West Cornforth, R.S.O., Ferryhill, Durham.

Mill's Patent Sectional Boiler Company, Limited (Boiler Makers, Mechanical and Electrical Engineers).—The annual return of this company, made up to January 12th, 1892, was filed on January 14th. The nominal capital is £100,000 in £5 shares, of which 12,060 have been taken up. Of these, 6,000 have been issued as fully paid, and £3 per share has been called on the remainder, resulting in the payment of £18,180. Registered office, 10, Withington Street, Pendleton, near Manchester.

Sheffield Telephone Exchange and Electric Light Company, Limited.—The following notice was filed on January 18th, 1892:—"At a general meeting of the shareholders of the above-named company, duly convened and held at the registered office, Station Road, Sheffield, on Thursday, January 14th, 1892 (pursuant to Section 142 of the Companies' Acts, 1862), the following resolution was duly passed, 'That the statement of the Liquidators and their report, be and is hereby accepted.' Dated this 14th day of January, 1892. (Signed) T. G. Shuttleworth, Wm. Johnson, Liquidators."

West India and Panama Telegraph Co., Limited.—The office of this company has been removed to Dashwood House, 75, Old Broad Street, London, E.C. (filed on the 23rd ult.).

BUSINESS NOTICES, &c.

Thomson-Houston International Electric Company.—This company have just transferred to the Union Electricitäts-Gesellschaft, Berlin, their businesses in Germany, Austro-Hungary, European and Asiatic Russia, Finland, Sweden, Norway, Denmark, Holland, Belgium, Switzerland, Turkey, and the Balkan States; all business, therefore, connected with the introduction and use of the Thomson-Houston systems of electric lighting, power, tramways and mining apparatus in the countries above referred to should be sent to that company. The manager hitherto of the Hamburg office of the Thomson-Houston International Electric Company, Mr. Louis J. Magee, will take an active part in the management of the new company, as its technical director. All business in Europe, in countries other than those named, remains under the direct management of the Thomson-Houston International Electric Company, and will be attended to at the general European offices of the company, 7, Rue du Louvre, Paris, where a competent staff of engineers will be kept, and from which office all information and estimates will be furnished. Mr. E. Thurnauer, who for several years has been in charge of the Paris office of the Thomson-Houston International Electric Company, has been appointed by the board of directors the general European manager of the company, and will have sole charge of all its affairs in Continental Europe, Great Britain and Ireland. The London

office of the company will remain at 35, Parliament Street, Westminster, S.W., although the lighting business for England and Ireland will be conducted by its long time agents, the Laing, Wharton and Down Construction Syndicate, Limited, of 38, Parliament Street, Westminster, S.W.

The General Electric Company, Limited.—We hear that this company have been appointed by the Electrical Power Storage Company, sole licensees for the sale of the E.C.C. dry cells. This cell is constructed on the most approved principles, and its suitability for telephonic and other electrical purposes is abundantly testified by the ready sale it is meeting in all quarters, and large repeat orders. A few of its most prominent features are as follows:—Absolute reliability; compact size; reasonable price; does not burst; short circuiting an impossibility; no creeping; unbreakability.

Catalogues.—We have received from the Edison and Swan United Electric Light Company a copy of their well-printed and profusely-illustrated new catalogue of electric lamp fittings and switchboards. This being the Exhibition edition, the cover of the price list has been illustrated to represent the Edison and Swan Company's exhibit at the Crystal Palace Electrical Exhibition, and the grand screen of nearly 10,000 incandescent lamps, which is illuminated for one hour every evening. We have pleasure in recommending this catalogue to the electrical trade generally.

Electric Light Installation at Minehead.—Mr. G. Hayward, of the Parade Wine and Spirit Stores, has had the electric light successfully introduced into his mineral water factory and other parts of his premises. The wiring of the premises, and fixing all the various lamps, switches, fuses, and other fittings were entrusted to Messrs. King, Mendham & Co., of Bristol, Mr. R. Clark and Mr. M. Capron assisting their electrician, Mr. A. Rouch. The whole installation has been carried out in accordance with the fire insurance rules.

The Mansion House Electric Installation.—We are asked to notify clients and friends of the Planet Electrical Engineering Company that the private view of their electric light installation at the Mansion House, announced for Tuesday, March 1st, has been postponed to Monday evening next, the 7th inst., between 6 and 10 p.m., to enable the Lord Mayor and Lady Mayoress to be present.

Tenders Wanted.—France.—The civil authorities of the town of Louvain are asking for tenders, by May 1st next, for the electric lighting of the Rue de la Station, La Place de la Station, La Grande Place, and the theatre. Tenders are also being invited for the electric lighting of the military establishment at Briançon, France.

Tenders Wanted.—Spain.—The Director-General of Communications in Spain is inviting tenders for 85 tons (metrical) of copper wire, 3 millimetres diameter, and 20,000 insulators. Any tenders sent in should reach the office of the Director of Comunications, Calle de Carretas 10, Madrid, by March 14th.

The General Direction of the Telegraphs of Spain at Calle de Carretas 10, Madrid are inviting tenders until the 26th inst. for the supply of 40,000 sheet zinc cylinders.

Tenders Wanted.—Bulgaria.—The General Direction of the Posts and Telegraphs of Bulgaria at Sophia are inviting tenders until the 8th inst. for the supply of 37 tons (metrical) of telegraph wire of 4 mm. diameter, half a ton of telegraph wire of 2 mm. diameter, 11,000 insulators, and 11,000 iron hooks.

The Electric Light in Westminster.—An installation of the electric light is being carried out in the new handsome pile of buildings in Westminster, known as St. Ermm's Mansions. The work is in the hands of Messrs. Croggon and Company, Limited, electrical engineers, of 16, Upper Thames Street, E.C.

Electric Light in Show-Rooms.—We hear that Messrs. Mappin and Webb have decided to have the electric light in their new show-room at Coventry, and the contract for running the wires and fittings has been given to the Sheffield Electric Light Company.

The Electric Light in the Strand.—Messrs. B. Verity and Sons, of Covent Garden, are putting in an installation of the electric light in the new offices of the Licensed Victualler's Gazette, in the Strand.

The Electric Light in the West End.—Messrs. Alpress and Belshaw, electrical engineers, of Westminster, are fitting up an installation of the electric light at 20, Charing Cross Road, W.C.

CITY NOTES.

Telegraph Construction and Maintenance Company, Limited.

THE directors' report states that the accounts for the year show a net profit of £85,199 8s. 5d., after charging the interest on the debentures. To this sum must be added £61,524 11s. 11d., brought forward from last year, making a total of £146,724 0s. 4d. From this amount is deducted the interim dividend of 5 per cent., paid July 14th, 1891, amounting to £22,410, leaving £124,314 0s. 4d. to be dealt with. Of this sum the directors propose to distribute a dividend of £1 16s. per share, absorbing £67,230, being at the rate of 15 per cent., and making with the amount already paid, a total dividend for the year of £2 8s. per share, or 20 per cent., free of income tax, leaving £57,084 0s. 4d. to be carried forward to the next account. All the company's steamships have been employed during portions of the year, 1891, in laying or repairing submarine cables in various parts of the world. Repairs have been effected in the Brazilian Submarine Telegraph Company's cables in the vicinity of Lisbon and Madeira, and in the Direct United States Company's cable on the coast of Nova Scotia. A duplicate cable has been laid for the Eastern Extension Telegraph Company between Madras and Penang, and a triplicate cable for the Eastern Telegraph Company between Aden and Bombay. A cable has also been laid for the Great Northern Telegraph Company between Oye, on the French Coast, and Fanoe, on the Coast of Denmark. During the year a length of 5,132 knots of telegraph wire has been insulated for submarine and land lines. The company's steamships, and factories at East Greenwich and Wharf Road, are in efficient condition. The directors regret to announce the death, on August 12th last, of Sir Thomas Fairbairn, Bart., who had served on the board for a period of over 21 years. Their former colleague, Admiral of the Fleet, Lord John Hay, G.C.B., being again free from service afloat, has been re-elected to a seat at the board in the place of Sir Thomas Fairbairn. The retiring director is Mr. George William Campbell, who, being eligible, offers himself for re-election. The meeting will have to appoint auditors for the ensuing year. Mr. John Gane (of the firm of Messrs. Gane, Jackson and Jefferys), and Mr. Patrick A. Glegg (of the firm of Messrs. Welton, Jones & Co.), who retire, offer themselves for re-election.

THE twenty-eighth ordinary general meeting of the company was held on Tuesday last at the offices, 38, Old Broad Street, E.C.

Mr. SHUTER (one of the directors), having read the notice convening the meeting, also the minutes of the two previous meetings, Mr. PHILIP RAWSON, J.P., who was presiding in the absence of Sir George Elliot, Bart., M.P., said that he was sure they would regret that their chairman was unable to be present, but he had sent a telegram from Egypt, where he was at present on his way home, saying that he was very sorry that he was unable to be present, and he congratulated the shareholders upon the report and accounts which were now before them. The report was then taken as read, and the chairman moved that the report and accounts be received and adopted. In moving their adoption, he was glad to say that he had not much to tell them, because the accounts showed continued prosperity, and they had done a fair amount of work in the past year which had brought about very satisfactory results. They would notice the accounts for the year showed a net result of £851,199 after charging interest on debentures. To this sum there was to be added £61,524 brought from the previous year, making a total of £146,724, which they had to deal with. From that amount the interim dividend of which was paid in July last, amounted to £22,410, to be deducted, leaving £124,314 to be dealt with, and of that sum the directors proposed to distribute a dividend of £1 16s. per share, absorbing £67,230, being at the rate of 15 per cent., and making, with the amount already paid, a total dividend for the year of £2 8s. per share, or 20 per cent., free of income tax, leaving £57,084 0s. 4d. to be carried forward to the next account. On reference to the report, they would see that the work carried out during the year had been considerable, and this was principally owing to the completion of the contracts which were entered into in the year 1890, that was, the laying of cables manufactured during the previous year. At the same time they had had some work in manufacturing new cables, also in connection with their gutta-percha works, and the home trade. With regard to the gutta-percha trade of the company, he had pleasure in saying that it continued in a satisfactory condition of an improving character. They much regretted the loss of the services during the last year of Sir Thomas Fairbairn, who had served for a period of over 21 years on the board; and they had been fortunate in being able again to secure the services of a former director of the company in the person of Lord John Hay, who, as they all knew, having received a high official command, was obliged to resign his seat on the board; and as through the death of their colleague there was a vacancy, they were very glad to fill it by re-electing Lord John Hay. The accounts, they would see, were drawn up on the old lines, and those who followed the figures from time to time would see that there had been no very great change. Altogether the position of the company was very satisfactory. They had a fair amount of work in hand, which would go to assist the profits of the present year. He had pleasure in moving that the report and accounts be received and adopted.

The motion was seconded by Mr. GEO. W. CAMPBELL.

Mr. CATER (a shareholder) asked why it was necessary to carry forward so large an amount as £57,000 to the next account. They had been told that the company was in a very promising condition, and under those circumstances he thought that if a bonus had been given at this time out of that £57,000, it might have been a substantial bonus, and still have left enough to be carried forward. If it was necessary to have a large amount in hand, why should it not be added to the reserve fund? He thought it would be a very interesting thing to the shareholders if the securities in which the reserve fund was invested were printed on the back of the report in detail, showing the interest accruing from those amounts at the end of the year. He was very glad indeed to hear the favourable report, and he hoped the directors would see their way clear in future to give a bonus as well as a dividend.

Mr. CROFT said that he had been a shareholder in the company for something like 25 years, and he was quite content, and believed that the great majority of the shareholders would also be content to leave the question of bonus or the question of reserve fund in the hands of the directors, feeling confident that they would maintain the same ability and integrity with which the company had been managed, in

the future as they had in the past. He would like to ask a question with reference to the laying of the cable between the Bahamas and the mainland. He saw that it had been laid by a rival company, and he would like to know whether their own company had a chance of laying that cable, and whether the matter rested with the directors or not.

The CHAIRMAN, replying to Mr. Cater, stated that he believed that by their articles of association, they could not have a statutory reserve fund beyond £50,000. Replying to Mr. Croft he said, that with regard to the Bahamas cable, the contract came before them, but it was not such a one as they thought they could accept.

The resolution was then put to the meeting, and carried unanimously.

Mr. GEO. W. CAMPBELL was unanimously re-elected as a director of the Company.

The auditors, Messrs. John Gane and Patrick A. Clegg, were next elected auditors of the company at the usual remuneration.

A vote of thanks to the chairman and directors, and other officers of the company, having been acknowledged by Mr. Rawson, the proceedings terminated.

Bath Electric Lighting and Engineering Company, Limited.

THE first annual meeting of the shareholders in this company was held at the works, Dorchester Street, last Saturday, under the presidency of Lieut.-Col. Vaughton, chairman of the board. The report of the directors was as follows:—

The directors have pleasure in submitting the first annual report and statement of accounts. The number of shares allotted is 3,246, upon which the sum of £31,981 has been paid. The result of the first year's operations of the company is, in the opinion of the directors, satisfactory. During the year the supply of current for incandescent lighting increased by 50 per cent., and the current is now supplied nightly to 102 arc lamps and 5,000 glow lamps. The gross profit amounts to £1,626 8s. 5½d., and after deducting directors' fees, salaries, and other standing charges, there remains a net balance of £585 19s. 1½d. The directors recommend that a dividend at the rate of 4 per cent. per annum (absorbing £556 16s.) be declared on the paid up capital. The directors have not written off any amount for depreciation, but all repairs and renewals have been charged to profit and loss account, and care has been taken to keep up all the plant to its original working efficiency. The engineer-in-chief, Mr. Ollson, reports: "In accordance with your request, I have pleasure in informing you that the plant is in good working order. The engines and dynamos have been kept in thorough repair, and the mains, both for arc and incandescent lighting, are in perfect order." The directors propose, in order to meet future depreciation of machinery, and to provide for exceptional outlay in any one year, to constitute a renewals fund, to which the balance of revenue, after providing for the dividend above mentioned, will be carried. The electric light is finding increasing favour in the city, as is evidenced by the many fresh installations. Among other buildings, the Bath and County Club has been fitted throughout. Deputations from various towns have visited Bath during the past year, for the purpose of inspecting the company's works and lighting arrangements. The general testimony is that the central station is one of the most successful yet carried out, and the only improvement suggested by the deputations is that in some parts of the city additional arc lamps should be erected. The directors anticipate that the coming year will show even better results, and they are giving special attention to the question of reducing the initial charge for installing the electric light. They are also considering the question of giving a day and night supply of electricity.

In moving the adoption of the report and statement of accounts, the CHAIRMAN said the directors trusted that both would be satisfactory to the proprietors. There had been a very considerable increase in customers for the incandescent lighting, and since that report had been drawn up several new contracts had been entered into. At present the plant was up to double the amount of the work now required, and of course they would be very glad when even more customers would require supplies. The day and night supply had been under the consideration of the board, but this would involve a considerable expense, and as yet it had not been settled when the matter would be carried out. It was also their intention to introduce meters in the course of the year. This would prevent any waste of current, and would place all customers upon an equal footing. By looking at the profit and loss account, they would see that the working expenses had been £4,318, while there still remained unpaid a balance of the purchase money of the undertaking amounting to £1,834. The council had appointed Mr. Gatehouse as their inspector, and the company would be only too glad to give him all the assistance in their power. He regretted very much that there had been two accidents during the year. One man, after some time, was able to return to his work, but in the other case the shock to the system had been too great and the unfortunate sufferer had succumbed to his injuries. The children left had been looked after, and he believed something handsome from London had been received on their behalf. At present their grandfather was taking charge of them. They were able, happily, to speak very highly of their chief electrician (Mr. Ollson) and the other members of the staff. During the year they had received visits by delegates from other towns in the north of England. Their general testimony was that the installation at the central station had been most successfully carried out, and the only improvement they suggested was that in some parts of the town additional arc lamps should be erected. That, of course, rested with the city authorities. Electricity was gaining ground every day, and there could be no doubt that, however useful gas might be, electricity would be the light of the future.

Major-Gen. JERVOIS seconded.

The report was then adopted.

On the motion of the CHAIRMAN, seconded by Mr. A. PITMAN, a dividend at the rate of 4 per cent. per annum was declared.

Mr. Butcher, of Messrs. Ham, Dennchey and Butcher, accountants, was re-appointed auditor, and the meeting closed with a vote of thanks to the chairman.

Keswick Electric Light Company.

THE annual report of the directors of the Keswick Electric Light Company has been issued. During the past year they have experienced great difficulties in having to run the station with plant only partially supplied with water power, in consequence of which considerable expenditure has been incurred in providing steam power to supply the deficiency. The business of the company continues to increase, and in order to meet the requirements it has been found necessary to make considerable extensions in the main wiring, the advantages of which to the company are not yet fully felt. Notwithstanding these difficulties and the extraordinary working cost, the directors have satisfaction in presenting a statement of accounts which shows a balance upon the year's working £87 8s. 5d., which, being added to the balance left over in the previous year, leaves a sum of £122 4s. They propose the payment of a dividend of 3 per cent., which will leave £44 10s. 4d. to be carried forward to the next account. The receipts from consumers amount to £541 11s. 2d. Mr. P. Thompson, Eskin Place, is the retiring director.

Actien Gesellschaft; Mix & Genest, Berlin.

AT the last meeting of the Actien Gesellschaft, the directors considered the balance-sheet, which showed, after writing off the usual for the depreciation on stock, a gross profit of M. 160,306, as against M. 69,668 of the previous year. They proposed to the shareholders to write off on plant, tools, &c., M. 17,428, and on patent account, M. 44,634, as against M. 4,159 written off patent account in the year 1890, and then to pay a dividend of 6 per cent. The extraordinary amount written off patent account, which represents nearly 4 per cent. on the paid up capital, is far in excess of the amount written off in former years, consequently there will in future only be a nominal amount to write off annually, and so leave a larger net profit available for dividends. Both the company's factories are now working at high pressure, and the orders in hand are much in excess of what they were at the corresponding period of last year.

The Electric Construction Corporation, Limited.

IT is proposed to increase the capital of this corporation from £500,000 to £750,000, as the directors "consider the time has arrived when additional capital can be employed to great advantage." The orders at present on hand unexecuted, we understand, amount to £150,000. The corporation have plenty of buildings and want a great deal of machinery, and it is thought that with more capital there is any amount of work in reach.

We notice a letter appearing in the *Financial News* of yesterday, in which a shareholder questions whether more capital can be employed advantageously, the shares being depreciated 40 per cent. to 45 per cent. below their par value. He speaks in very unfavourable terms regarding the management of the corporation.

The Pioneer Telephone Company, Limited.

WITH a capital of £100,000 in shares of £10 each, the Pioneer Telephone Company, Limited, has been formed for the purpose of acquiring certain rights and interest secured to the Electric and General Investment Company, Limited, under which the undertaking of the Mutual Telephone Company, Limited, in Manchester, may be acquired as a going concern. It has also been formed for the purpose of providing the necessary capital for the New Telephone Company, Limited, the objects of which are the acquisition, establishment, and working of telephone exchanges throughout the United Kingdom under license. Seven thousand five hundred shares are now offered for subscription. We notice an article in the *Financial News* of yesterday upon this subject.

The Windsor and Eton Electric Light Company, Limited.

THIS company has been formed with a capital of £30,000 (with power to increase), divided into 5,950 shares of £5 each, and 250 founders' shares of £1 each for the purpose of supplying electricity under a provisional order to the Borough of Windsor. The ordinary shares are entitled to a preferential dividend of 6 per cent. out of the profits of each year, and any surplus profit for the year is to be divided between the ordinary and founders' shares, in the proportion of two-thirds to the ordinary shares, and one-third to the founders' shares. 5,700 ordinary shares of £5 each are offered for subscription. A contract has been made with Messrs. J. E. H. Gordon & Co. to equip the necessary installations. The list will close to-morrow, Saturday, March 5th.

Submarine Cables Trust.—On and after the 15th inst. the coupon due in October last of the Submarine Cables Trust will be paid in full by Messrs. Glyn, Mills & Co. The coupons should be left with the bankers for examination four clear days before payment.

The Atlas Electric Appliances Company, Limited.—A general meeting of the above-named company will be held at the offices of the Liquidator, on April 1st, for the purpose of receiving the final report of the winding up.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (Feb. 25th.	Closing Quotation. (March 3rd.)	Business done during week ending (March 3rd, 1892.) Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102	99 — 102	...	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	49 — 50	49 — 50	...	...
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	88 — 89	88 — 89	89	88½
2,849,510*l*	Do. do. Deferred	Stock	11⅜— 12¼	11⅜— 12¼	12⅛	12
130,000	Brazilian Submarine Telegraph, Limited	10	10¾— 11¼	10¾— 11¼	11 1/16	11
53,200*l*	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3½— 3⅝	3½— 3⅝	3 5/16	3⅛
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2 — 2¼	2 — 2¼	2⅛	...
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	3 — 4	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½— 3½	2½— 3½	...	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	10	6½— 6¾	8 — 8½	...	...
$7,716,000	Commercial Cable, Capital Stock	$100	153 —157	152 —157	154½	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	⅜— ½	⅜— ½	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½— 6	5½— 6	5 13/16	...
16,000	Cuba Telegraph, Limited	10	10 — 11	10 — 11	...	...
6,000	Do. do. 10 p. c. Preference	10	16 — 17	16½— 17½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3½— 3¾	3½— 3¾	...	...
6,000	Do. do. 10 p. c. Preference	5	8½— 9½	8½— 9½	...	...
60,710	Direct United States Cable, Limited, 1877	20	11 — 11½	11 — 11½	11¼	11
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅝— 14¾	14⅝— 14¾	14¾	14⅝
70,000	Do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15⅝	15 1/16
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	105 —108	105 —108	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	107 —110	107 — 110	108½	108
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅞— 15⅛	14⅞— 15⅛	15⅛	14⅞
78,300*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105	102 —105	...	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	102½	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	106 —109	106 —109	...	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 —104	101 —104	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104	101 —104	103¾	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —102	99 —102	101	100½
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5¼— 5⅜	5½— 6	6	5⅝
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	2⅜— 2⅝	2¼— 2½	2⅝	2¼
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3 — 3¼	2⅞— 3⅛	3 1/16	2 15/16
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1⅞— 2	1⅞— 1⅞	1 13/16	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅞— 10⅛	9⅞— 10⅛	10 1/16	9⅞
180,042	Do. do. 6 p. c. Preference	10	14⅞— 15⅛	14⅞— 15⅛	15 1/16	14⅞
150,000	Great Northern Tel. Company of Copenhagen	10	18⅝— 19¼	18⅝— 19¼	...	...
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	106 —109	105 —108 xd	107	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	7⅜— 8½	7⅜— 8½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½— 10½	9½— 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21 — 22	12½— 20½	20⅜	20⅛
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	103 —105	103 —106	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	42½	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	3½— 4½	3½— 4½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	8 — 9	8 — 9	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	2⅝— 2⅞	2⅝— 2⅞	2¾	2⅝
10,000	Do. do. fully paid	5	4⅛— 5	4⅜— 5	4⅝	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	106 —109	103 —106 xd	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	8½— 8¾	8½— 9	9	8¾
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4½— 4⅝	4½— 4⅝	4 5/16	4½
15,000	Do. 6 p. c. Cum., 1st Preference	10	13 — 13½	13 — 13½	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	11½— 12½	11½— 12½	12	...
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	104 —107	104 —107	105½	105
250,000*l*	Do. (issued at 5 p.m., all paid)	...	54 — 57	54 — 57	...	...
6,318	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	4½— 5½	4½— 5½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	¼— ⅜	¼— ⅜	...	...
9,000	Reuter's Limited	8	7½— 8	7½— 8	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8¼— 8½	8¼— 8⅝	8½	8¼
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7¾— 7⅞	7¾— 7⅞	7 11/16	...
3,381	Submarine Cables Trust	Cert.	115 —120	116 —121	117½	...
78,949	Swan United Electric Light, Limited ... (£3½ only paid)	5	4 — 4½	4 — 4½	4¼	4⅛
37,350	Telegraph Construction and Maintenance, Limited	12	45 — 47	45 — 47	46½	45½
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	...	...
58,000	United River Plate Telephone, Limited	5	1 — 2	1 — 2	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	80 — 90	80 — 90	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7 — 8	7 — 8	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	101 —104	99 —102 xd	102¾	...
30,000	West Coast of America Telegraph, Limited	10	4 — 5	4 — 5	4 1/16	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	102 — 106	102 —106	102¼	...
67,007	Western and Brazilian Telegraph, Limited	15	10⅛— 10⅜	10 — 10⅛	10⅜	10 3/16
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6¼— 6⅜	6 — 6¼	6 1/16	6¼
30,364	Do. do. do. 5 p. c. Deferred	7½	4 — 4¼	3⅞— 4¼	4 3/16	...
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	101 —104	101 —104	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	101 —104	101 —104	...	...
88,321	West India and Panama Telegraph, Limited	10	1⅝— 1⅞	1¼— 1⅝	1 11/16	1⅝
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9¾— 10¼	9¾— 10¼	9¼	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8¾— 9½	8¼— 9½	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	99 — 103	99 — 103	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	118 —122	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	10)	98 —102	97 —100 xd	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5¾— 6⅛	6 — 6⅛	6⅜	6¼

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid) 7¼—7⅜.—Electric and General Investment, Founders' shares, 150—200.—Elmore Foreign and Colonial Copper, Founders' shares, 6½—7½.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable, 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 4½—5.—7 per cent. Preference Shares of £5 (fully paid) 5½—5⅝.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅝—6, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5¾—6.—Liverpool Electric Supply Shares of £5 (fully paid), 4⅜—5.—Do. shares of £5 (£3 paid), 2⅜—2⅝.—London Electric Supply Corporation, Ordinary (£5 paid), ⅛—1⅛.—Do. 6 per cent. Preference, 1¼—1¾.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—⅜.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—½.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—¼.—Do. Debentures, 103—½.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ½—1.—£5 Preference (fully paid), 2¼—2⅜.—Ward's Electric Car (£10 paid), 1⅜—1½.

BANK RATE OF DISCOUNT.—3 per cent. (January 21st, 1892).

LEGAL.

Lane-Fox v. Kensington and Knightsbridge Electric Lighting Company.—In the Chancery Division of the High Court of Justice on Thursday, last week, before Mr. Justice A. L. Smith (for Mr. Justice Romer), the trial of this action, which is brought by the plaintiff for the usual relief in a patent action, was proceeded with.

In further cross-examination, Prof. PERRY said the attempt to light up the dining room of the Grand Hotel, Charing Cross, was successful for a few days, and then naturally they added cells in order to prevent the lamps going a little too high or a little too low. By means of switches and other devices fresh cells could be introduced and other cells shut off. There was no provision in the Lane-Fox patent for any such arrangement or device. On the contrary, he presumed Lane-Fox contemplated that the operation or working of his accumulator would be automatic. He made experiments and adopted improvements for which he and Prof. Ayrton had taken out patents. The patents had reference to switches and such devices for the purpose of regulating the number of cells in action. It was only a small installation, but was successful up to the time of his company handing it over to another company. He was connected with it for a period of nine months, and during that time he was mainly engaged in changing the cells which worked badly. After his company handed it over, he knew practically little about it. He was not aware that the installation had been found unsuccessful and ordered to be removed, but it was very natural that it should be removed, as the cells were not so good as they ought to have been. The cells used by him at the Grand, in 1878, were not cells known at that time, but were what he thought were improved cells upon anything known at that time, though that did not turn out to be the case.

As a skilled electrician, will you undertake to say that the Lane-Fox system, as described in his patent, could be practically worked—I do not mean as an experiment, but practically worked as a practical system—without directions for varying, increasing, or diminishing the number of cells in operation by means of switches and other devices?—Yes, I am sure it could.

But you do not know of any instance where it has been done?—No.

Had you anything to do with the installation in the building in which we are sitting?—No, I had not.

Then you do not know whether the Lane-Fox system was tried here by Mr. Compton?—I do not.

I am instructed by a gentleman conversant with the subject, that in order to charge a battery fully, the charging current must be raised from 100 to 125 volts. You say you tested this experimentally. What were those experiments?—I have made several experiments, one with only one cell, and another with 48 cells, which would give about 100 volts. In this case the experiment would last six or seven hours, and the current would increase up to 108 or 110 volts. In this case various ampères would be used. Roughly speaking, the experiment would take 50 ampères. The plates used on the occasion were not nearly large enough.

Cross-examination continued: The voltage of the current generally drops as the cells get exhausted, and towards the end of an experiment would suddenly drop to nothing. A change of 3 volts would be noticeable in the lamps in a room, but a change of 1 volt would not be noticeable. In a 100-volt lamp a drop to 97 would produce a bright red light which would not be useful for illuminating purposes. It was found necessary to maintain the current by bringing new cells into operation as the mean potential falls, if they wished to save expensive cells, and this was assuming the generator was running and the pressure kept constant. With large, elaborate, and expensive cells the drop was very small indeed. If they did not charge the secondary battery fully for the purpose of working, he believed it was extremely injurious to some kinds of secondary cells. He could not say whether his observation would apply to the battery used in 1878, as he had no information about it. In his opinion, earth would work as a return circuit, but he had not used it. If the Board of Trade would allow him, and he was distributing anything over two miles, he would use the earth as a returning conductor.

Re-examined by Mr. MOULTON, WITNESS said that when the earth was used it could not perform any function different from any other conductor. That was well known in 1878. Provided there were a good connection with the earth, there was no limit to the current it would carry. When a return conductor was used, good connection must be made. Good connection meant a connection of such a nature that there was slight resistance to the passage of the current. There would be more resistance from a dry surface than from a wet one. The mode of making good connection with earth was perfectly well known in 1878. In connection with telegraphy earth connections were especially well known.

Mr. JUSTICE SMITH asked for the date when the Board of Trade prohibited earth returns.

The ATTORNEY-GENERAL said he believed that was somewhere about 1886 or 1887, but he would get the exact date.

Re-examination continued: The cost would decide him as to whether he would use an insulated return or an earth return where there were no houses. In 1878 any electrician would know that he could use the one or the other. In his opinion there was no necessity to have an arrangement for switching the cells on and off if the accumulators were of a sufficient size. The automatic arrangement would be always more or less felt. If the size of the battery were increased, that would make it more automatic. It was better to have several batteries at different places in the mains, because the batteries were thereby made more automatic; it was even better than having the size of the batteries increased. Directions were given in the plaintiff's specification with regard to having abundant battery power. He referred to the words, "The cells should have a very large conducting surface, and there should be several batteries connected up to the various points of the mains," &c. The amount of rise was not large if the currents were moderate, compared with the batteries. There was no need, in order to charge these batteries, so as to make them work, to go up to 108 or 110 volts, or to sink down to 97 volts, They would charge and discharge with small additions of voltage. The difference in voltage with small currents was so small, that with a very accurate voltmeter, he could not measure it; he therefore knew it must be less than 1½ per cent. In his opinion, the give-and-take described by Mr. Lane-Fox would take place continuously. The real cause of his trouble with his installation at the Grand Hotel was that his secondary batteries were bad. He tried to light with a dynamo, a steam engine, and a secondary battery. He had not read Lane-Fox's specification at that time, and did not know that it was Lane-Fox's invention—he thought it was anybody's invention. (Laughter.) He had not been able to find any description of that system he was referring to earlier than Lane-Fox's specification. Lane-Fox's cells were bigger and better than those he (witness) used. In his opinion if he had used good cells they would have succeeded.

Mr. JUSTICE SMITH: Why do you say your cells were bad?

WITNESS said they were not Planté's cells, but what was called Faure's improvement of Planté. The failure was not due to any imperfection in the scheme as described by Mr. Lane-Fox. Regulation went on all the time, whether the battery was charging or discharging. There was no real difficulty in making a connection with earth which would conduct large currents. Large currents were used for tramways. In some cases uninsulated circuits were used. A plate coated with platinum could be used, but he had not thought of that.

Sir HORACE DAVEY: Give me an idea of the size of plate which you say would be sufficient to enable an electrician to work without a re-arrangement of switching?

WITNESS: Plates would be required five times the size used in the batteries at Kensington.

Have you ever seen a plate five times the size of ours at Kensington, namely, a foot by 15 inches?

WITNESS: I think I have seen plates five times that size at Kensington.

Do you mean to say we use five times as many?

WITNESS: Five times as many or plates of that area.

What area would be required to do away with the necessity for a switching apparatus?

WITNESS: Five or six times the area of plates employed in each cell. It is the same thing whether it is a small current in a small cell or a large current in a large cell.

Sir HORACE DAVEY said he thought he had got enough to enable him to give evidence.

In reply to the ATTORNEY-GENERAL, WITNESS said cells consisted of a number of plates parallel to one another, some positive and some negative, the total effect depending on the surface area of the plates in the circuit.

Mr. ST. GEO. LANE-FOX, the patentee, examined by the ATTORNEY-GENERAL, said he had for many years studied electricity. He might, he thought, call himself an electrical engineer, having managed electrical works. For many years before 1878 he had made a practical study of electricity, and had before then taken out patents. He had worked at electricity for the purpose of applying it to street lamps, and with the sanction of the Metropolitan Board experiments were made in Pall Mall.

You allege this patent of yours has been infringed by a great many other companies for many years?—Yes. The Brush Company, who own this patent, brought an action against Mr. Edison for infringement, and a compromise was entered into; they acknowledged the patent and accepted a licence.

What were the known ways of generating electricity?—Either by means of magneto-electric machines, or by what are called dynamo machines.

What was there new in your specification?—The idea of a constant potential with a variable load.

Must there be a constant potential?—Yes; otherwise the illuminating power of the lamp would not be constant.

Was your idea to be able to keep your current at each lamp constant, though you had a variable load?—Yes.

Had that idea ever been published before 1878?—No.

Was it a departure from many of the things that had been written respecting electric lighting?—It was.

In 1878 was "earth" or "earth return" perfectly well known?—Yes.

What did it mean?—An electrical communication between two points, the special insulation of which is unnecessary.

For the purpose of earth return, does it make any difference whether a strip of metal is used, or whether the earth is used?—Electrically, none.

Does it make any difference whether it is insulated or not for the purpose of earth return?—No. To make the return insulated the copper wire must be surrounded with some other material through which the current will not pass.

Is the multiple arc system the system now in use by the Kensington and all the other companies in London?—It is.

Are you aware of any English enunciation of 100 volts being about the right standard to keep the electromotive force of the electric conduct main at, prior to the date of your patent?—No.

Is that the pressure at which the defendants, as well as other companies, work now?—Yes; that discovery was the result of my own invention and research.

Were Planté's batteries perfectly well known at the date of your patent?—Yes, and to-day Planté's cells were useful for the purposes of his patent.

For a long time was it thought that Faure's improvements was better

than Planté's?—Yes. Faure's were called pasted plates as distinct from lead plates. To-day Planté's were the best for the purposes of his (witness's) patent, though for years (with the exception of himself) people had tried to work Faure's improvements.

Assuming your generator is running all the time, do your secondary batteries act as a regulator when being charged and discharged?—They do.

What ways are there of increasing the conducting surface?—Increasing the area of the total positive and total negative plates in the cells, or by increasing the number of plates. You could also put two batteries working side by side, each connected with the mains.

What effect would a number of batteries have if put at different portions of the main?—That of making the system more sensitive.

Would the result be that you got a more constant pressure?—Certainly.

Is that the result of your research?—Yes.

Does the specification contain sufficient directions to enable a multiple incandescent system to be worked?—Yes.

What would be the effect if the system were worked with earth returns in the sense of uninsulated returns?—It would work well if the connections were well made. It is not necessary to have an arrangement for the switching of the cells.

At this stage the hearing of the case was adjourned until to-morrow.

FRIDAY, FEBRUARY 26TH, 1892.

In further examination by the ATTORNEY-GENERAL, Mr. LANE-FOX said that as far as he knew, prior to his patent, there had never been any publication of the use of Planté's batteries as regulators of the electric light. Prior to his patent an electric light was always a variable light. No one before then had ever pointed out the necessity of maintaining a constant pressure with a varying light. The object of having several of these batteries always between the main and the earth at various places in a corresponding position was to increase their effect as regulators of the electrical pressure.

And they do so?—Yes.

Do you know whether the Kensington and Knightsbridge Company have on their system secondary batteries both at the generating stations and at other places?—They have.

Had the regulator which you described and disclaimed anything to do with the same functions as the secondary battery performs?—It had not exactly the same functions, but analogous. Its functions were to automatically regulate the action of the steam engines employed to drive the generator. If the secondary batteries were thoroughly efficient the regulators would become less necessary.

To what type of secondary battery are the users now reverting?—To the original Planté.

Except by increasing the conducting surface in the way described, either by increasing the number of plates or batteries, was there any other modification of Planté required?—No.

WITNESS having explained to the Court the fall of pressure potential in secondary batteries, was asked:

Assuming you wanted to have more capacity of your batteries, could you double the batteries by putting on another group of 50, and adding these?—Yes.

And others, side by side, to any extent?—Yes.

They would be parallel, and not in series?—Yes.

Was your invention exhibited elsewhere?—At Paris there was a sort of initiation by M. Faure, but not with my authority or co-operation in any way.

Was there an exhibition of your system at the Crystal Palace in 1882?—Yes, under my superintendence, chiefly by the Electrical Power Storage Company.

Were the secondary batteries there used supplied by the Electrical Power Storage Company?—Yes; the system being the Sellon and Volckmar, which was brought out by that company—a supposed improvement of the Faure battery.

In other respects, was it your system?—Yes. But during the greater part of the exhibition the batteries were severed from their connection with the main, because very little charge was necessary to show the lights, and, for economy's sake, it was not constant; the generator was not running constantly.

Did it work successfully?—Yes.

Where else have you put in operation your system?—At Lady Conyers's, 108, Queen's Gate, in 1882.

What generator was used?—A dynamo, with a steam engine.

What batteries?—Some lent me by Mr. Sellon.

Whose lamps?—Mine, which were carbon lamps made at the Brush works.

Was it successful?—Quite. It was for a ball, and was the first ball room ever lighted by incandescent lights. It was for a ball, and was taken down the next day.

Mr. JUSTICE A. L. SMITH: There was no engine regulator, I suppose?—No, not even the ordinary speed governor.

The ATTORNEY-GENERAL: Were the secondary batteries put to act in the way described by your patent?—Yes.

Was the illumination of the lamps constant?—Quite, except that there was a slight hitch owing to a crowd getting into the engine room and so upsetting some of the connections. That, however, was immediately rectified.

The ATTORNEY-GENERAL: I do not suppose that will be suggested as a blot on the patent.

Sir HORACE DAVEY: I shall suggest that the lights went out.

WITNESS said there was no failure so far as the working of the system was concerned.

Was the position of the secondary batteries exactly what was described in your patent?—Yes.

Have you worked it elsewhere?—It was used for the lighting of the Brush offices at Belvedere Road, Lambeth, for a great length of time, but I do not say the system may not have been modified and altered. A steam engine was used with a dynamo for generator and the E.P.S. battery. There was no electric governor controlling.

Mr. JUSTICE A. L. SMITH: There was a regulator?—Yes.

But no regulator on the steam engine?—No.

By the ATTORNEY-GENERAL: The secondary batteries were used as described in his specification and were worked successfully. His own incandescent lamps were used, but there were alterations from time to time in the number of lamps and the arrangements of the connections.

Mr. JUSTICE SMITH: Before these modifications was the lighting constant?—The pressure was constant.

By the ATTORNEY-GENERAL: The changes or alteration in that installation were not made in consequence of any failure of his system to maintain a constant pressure. They were experimenting generally. Uninsulated, or bare copper wires were used. The secondary batteries gave out many times owing to the peroxide of lead on the plates becoming loose and dropping off. The disasters were not occasioned by any defect in his system, but was due to the bungling of stupid workmen. Since then pasted batteries had been improved and discarded. In 1883 an installation designed by him was set up and worked for the lighting of the Imperial Opera House in Vienna. It did not run very long, there being great difficulties with the boilers and secondary batteries, but he did not know that there was any complaint made against his system. In a great measure he designed the system which he believed was running successfully to this day at the King of Roumania's palace, at Senar, in the Carpathian mountains. It was carried out, under his instructions, by the International Electric Company, of which he was a director, with the E.P.S. Company's batteries. That was very successful.

What companies in London are now adopting the system described in your patent?—The Kensington and Knightsbridge, the Westminster, the Notting Hill, the Metropolitan, the St. James's, and a great number of provincial companies.

What companies have taken licences?—The Edison Manchester have made an arrangement with the Brush Company when my patents were in their hands.

Mr. JUSTICE A. L. SMITH: Do you say they pay royalties?

The ATTORNEY-GENERAL: He said they took a licence. There was a valuable consideration.

WITNESS: They work it under a licence. What the valuable consideration was they would not disclose to me. It led to a compromise.

The ATTORNEY-GENERAL: You have inspected the defendant's works?—Yes.

Mr. JUSTICE A. L. SMITH: About when did these companies set up?—Recently—I think about five years ago.

The ATTORNEY-GENERAL: These patents were not then in your hands?—No. I got them back two years ago. I was not in a position to enforce them till then.

Do you say the defendants are now using your system?—I do.

Mr. JUSTICE A. L. SMITH: Have they regulators on their engine?—No. I believe they have tried one or two, but that they do not permanently use them.

By the ATTORNEY GENERAL: The defendants are using secondary batteries as regulators. Roughly, the defendants were using batteries connected up at various points with the mains, so that by increasing the electromotive force during the hours when not much electricity was being used, they will become charged, and the electric force would be stored up in them so that a sufficient supply would be available when the electromotive force failed, owing to the draught on the mains, when the force was most used and needed. But there was just the fact that they did use a switch arrangement. During the time the number of cells remained switched in, the operation was exactly the same as in his patent. That applied to switching out also, the object of switching in and out cells being to make a battery of small capacity do the work of a battery of large capacity, by using excess energy. If they had a larger amount of surface area in each cell, or a larger number of cells, it would not be necessary to switch in and out. The defendants used the Crompton-Howell cells (very good ones), which were practically Planté's, with such modifications as the exigencies of manufacture suggested. The St. James's Electric Light Company used his system, and the engineer had told him they scarcely ever changed the number of cells in action. The defendants used the 100-volt current in their mains, and an insulated return. They gained nothing whatever by having insulated returns. He did not know whether, if the conductors were big enough, the pressure would be more constant with a dry-earth return than with an insulated return. Provided there were good connection, the earth return would be an advantage if the conductor were small. Clarke's specification did not describe his (witness's) invention, nor would anybody be led by that to construct what he had described. The object of Clarke's patent was to ignite a tinder-box, and, in the proper sense of the term, there was no electric lighting in it at all; it was for a momentary purpose, and had nothing to do with constancy. The whole point of his (witness's) invention was constancy at the lamps. The same thing applied to Achard's patent, which, so far as he could see, bore not the slightest resemblance to his. His patent was disclaimed on January 26th, 1882, and on July 30th, 1883, and the second was opposed by Crompton & Co., the engineers of the defendant company.

Cross-examined by Sir HORACE DAVEY, Q.C., WITNESS said that Messrs. Crompton said his patent could not be worked without further inventions. And they say so still, and I think the learned law officer allowed the disclaimer on the ground that that question might be raised in an action at law.

WITNESS: Lord Herschell said the validity of the patent was not before him.

By Sir HORACE DAVEY: He was quite a youth in 1878 (about twenty), but he had already taken out several patents, and was on the Council of the Institute of Electrical Engineers at the time. He had works, and employed a great number of men before 1878. He was accurate in saying that before his patent of 1870 no one had suggested 100-volt currents as the most suitable for electric lighting.

Let me refer you to a passage in Staite's specification (1847), which says:—"The electric current may be obtained from a galvanic apparatus, and may be used of various intensities and quantities. A good degree of intensity to use is such as would be afforded by 100 cells of the usual sort employed in galvanic apparatuses."

WITNESS admitted that approximately that would be 100 volts, but added that he did not say for electric lighting, electrical distribution as described in the patent.

Mr. JUSTICE SMITH said that what he took down was, "The keeping of a constant pressure at 100 volts was not enunciated before."

Sir HORACE DAVEY: Your lamp was a lamp with a platinum-iridium burner?—Yes.

Is it in use at the present day?—No.

And you claim all the lamps which we see around us as being within your specification?—Yes.

The Edison Company does not take the same view?—Yes; they have acknowledged the validity of my patents, and all these lamps are now licensed under my patents.

But the Court of Law did not?—Yes.

The Brush Company brought an action against the Edison Company, founded on several patents of yours, which action was discontinued?—Yes. I do not remember the terms, but I believe the Edison Company waived their claim for damages against the Brush Company.

But no royalty is paid?—A royalty is paid of a farthing per lamp manufactured by the Edison Company to the Brush Company under their patent of 1880 for improvements.

Not under this patent of 1878?—No.

Is the lamp described in your amended specification part of the "mode or system of distribution" which is referred to in the claim in your amended patent?—Yes, I say that conditionally. To make incandescent lamps, I have here described the conditions and properties which are necessary for working lamps on this system.

The Kensington Company do not use iridium or platinum?—That is a mere matter of preference.

Their conductors are *in vacuo*?—Yes.

There is no suggestion of a vacuum in your specification, is there?—Not in this patent.

In the next place, I think the leading wires are hermetically sealed in a glass bulb. There is no suggestion of that?—It is the same here.

Persons before you had suggested the use of platinum and iridium as a luminous bridge or conductor?—Yes.

As to the regulator which you describe in your original specification, that was not struck out until the second disclaimer?—No.

Was that necessary in 1878?—No. The word "necessary" was carelessly used.

Earth prior to 1878 had been used universally as a return conductor in telegraphic systems?—Yes.

The current in a telegraphic system is as weak as a fraction of an ampère?—Yes.

And the resistance of a return telegraphic conductor going to earth is as high as from 100 to 300 ohms?—Often.

And the resistance of the earth, compared with the resistance of the return wire of an electric circuit, would be considerable?—That depends on the sectional area of the wire and the extent of earth used.

Is not an earth plate used to distribute the current over a larger space than the wire?—Yes.

Supposing you had a return wire, the resistance of which was only a $\frac{1}{1000}$th part of an ohm, and therefore inconsiderable compared with the resistance of the soil, would not that be a greater necessity for an earth plate of a larger size for the purpose of distributing the current when it reaches the earth?—Yes, it would require a larger area for a larger current.

Suppose you had a current of 1,000 ampères?—It would require an altogether unwieldy size of earth plate. I may say at once that I think Prof. Perry was mistaken in what he said about that.

An altogether impracticable size?—I do not know that.

I am told that the earth plates for such a current would have to cover more than an acre?—Quite so—the size would be unwieldy. At a short distance the use of a soil return would be ridiculous.

Take your figure 5, and show me where there is anything to convey to an ordinary electrical working man an idea about insulation?—I say he would not see any idea; he would conclude from this figure that no insulation from the soil was necessary or desirable. I assume a certain amount of knowledge and common sense on the part of the people who would apply this.

The ATTORNEY-GENERAL: We shall give evidence as to the meaning of the word "earth."

Sir HORACE DAVEY: My witnesses are practical men, and they will give evidence that "earth" means *earth*.

To the witness: What did you mean when, in your specification, you say, "The other pole of each electrical generator is connected with the earth?"—A suitable return conductor, where the path of the current need not be guided by means of any insulation. I would say that an insulated conductor was an equivalent of an earth return, but not identical. If an uninsulated conductor answered the purpose, it would be included certainly. There is a distinction between saying insulation is unnecessary and insulation must not be.

In 1878 there was no experience of systems for the purpose or distributing an incandescent light?—No.

Nor of the conveyance of electric currents of 1,000 ampères at this tension of 100 volts?—Not quite of that quantity, though something like it was used for arc lights which were lighted in a series, the current being only about 15 ampères.

The conditions were totally different?—Yes.

Pressed as to the meaning of his specification, witness said that the gas or water pipes were a system of return conductors. According to his view "the earth *e*" might be conveniently gas or water pipes for such a purpose.

Sir HORACE DAVEY: I will now suggest to you my meaning of that sentence, namely, that gas or water pipes where they exist would form a convenient connection between one pole of the lamp and the soil.

WITNESS: I say that is a strained and improper interpretation.

I understand you to say that the essential feature of your system is that the electromotive force of the current produced by the dynamo is to be kept as nearly as possible constant at 100 volts?—Yes.

That has nothing to do with secondary batteries?—Secondary batteries were the means by which the pressure of the dynamos were kept at that potential.

The adding to or diminishing of the current depends upon the running of the dynamo, does it not?—No, on the presence of the batteries.

Do you say that?—Yes.

The only mention in your provisional specification of secondary batteries is: "A number of secondary batteries such as Planté's will serve as a kind of reservoir?—Yes, that is the sole mention. The reservoir referred to was the kind of reservoir which kept the potential constant. That was in my mind the whole time.

Mr. JUSTICE A. L. SMITH: I understand you to say that this specification meant that as it is stored up, and as it is wanted either to increase or decrease, it is let out automatically.

WITNESS: Quite so; it is available there by means of the connections described.

Sir HORACE DAVEY: And you say you have secured that by your patents?

WITNESS: Approximately—it is a matter of degree.

You used your reservoir, like Planté, to store up electricity and to let it flow when wanted?—Planté never contemplated the combination described in this specification.

Mr. JUSTICE A. L. SMITH: Planté never suggested an automatic taking in or letting out.

WITNESS: Never.

Sir HORACE DAVEY: Yes.

Mr. JUSTICE A. L. SMITH: It may be so, but I cannot see anything about it.

Sir HORACE DAVEY: There is nothing in its being automatic.

Mr. JUSTICE A. L. SMITH: I should say it made all the difference in the world, if you asked me, whether a thing acted by itself, or whether a man must intervene and turn a tap.

Sir HORACE DAVEY: The defendants do not use that automatically.

WITNESS: Indeed they do.

Mr. JUSTICE A. L. SMITH: I know what is coming perfectly well. I see the case, but I say, as far as Mr. Lane-Fox goes, he gives the go-by to the switches and everything else.

Sir HORACE DAVEY: I hope to convince your Lordship that without the switching——

Mr. JUSTICE A. L. SMITH: Remember all that I said, namely, that it will take a great deal to induce me to think they are identical, sir.

Sir HORACE DAVEY: If the circuit were complete, unless prevented by a tap or switch or something of that kind, the electric current would flow out of itself?

WITNESS: Precisely so.

Asked as to what directions there were in his patent as to the extent to which the batteries were to be charged, WITNESS said the pressure was to be maintained as nearly as possible at 100 volts. The attendant would know when the batteries were sufficiently charged by the brilliancy of the lamps. Something was left to common sense and ordinary intelligence; the turning on and off of steam by hand was a perfectly well known matter. He did not agree with the defendants that to charge the battery for the purpose of working it they would have to run a current of about 117 volts. Carbon lamps were better than platinum, because they stood higher temperatures. A very rapid drop of 1 volt would make the lamp flicker, but not perceptibly—3 volts might. Increasing the size of the batteries would diminish the mischievous drop or fall. In 1882 Mr. Crompton put an installation in these Courts, under a contract with the Government. He believed the installation was in accordance with his system. He had never heard of the lamps flaring up and frightening everybody; but he could imagine anything from Mr. Crompton's installation in those days. He did not remember Mr. Crompton asking him to come and see it, or consulting him about it; he might have done.

Mr. JUSTICE SMITH: As he put up your system, he ought to have paid you a royalty, oughtn't he?

WITNESS: At that time I had no right to sue; my patents were in the hands of the Brush Company. I never heard of his paying a licence to anybody. He got an indemnity for it, on the ground that it was an installation put in prior to the disclaimer, and he applied to get an indemnity for this installation. He heard that the accumulators were removed. He believed they were E.P.S. accumulators, but did not know.

You never suggested at the time that it was owing to inferiority of any of the batteries that the system did not answer?—No; I have no recollection of the interview with Mr. Crompton. I think it is quite probable that the cells were lead, and became defective.

In the provisional specification of your other patent, you say: "Or

I sometimes supply each of these reservoir batteries with commutators," &c. That was a suggestion that by means of a commutator, low tension might be converted into higher tension?—Yes.

Mr. Justice A. L. Smith asked what a commutator was.

The Witness said it was a switch apparatus by which the number of the cells could be regulated, and the tension of the current being discharged from them. This was three days after he took out his former patent, the idea occurring to him as an improvement between the 9th and 12th October. He had good reason for believing his system, as previously described, was superior to this alternative method. In the installation in Vienna there was a much more elaborate apparatus for adjusting the current by means of switches and other devices similar to the defendants' arrangements for producing special effects being required. There was a similar arrangement for switching on and off cells at the King of Roumania's installation. He did not repudiate them: he invented them first, five years before Prof. Perry and eight years before Mr. Crompton. Lady Conyers's installation was for one night only, and no switches were used. The breakdown there was caused by some people in the engine room kicking over the connection. At first, in the Brush Company, there were no switches on; the light became irregular after the batteries had deteriorated. Switches were used afterwards. The switching apparatus had the advantage of enabling a smaller battery to do the work of a large one. For all he knew to the contrary the Brush Company put in an adjustment by means of a switch, &c., for the purpose of correcting the irregularities of the light.

At this stage the hearing of the case was adjourned until Monday, the 29th inst.

Monday, February 29th, 1892.

The hearing of this case was resumed with the further cross-examination of Mr. Lane-Fox by Sir Horace Davey.

The Witness said that at the Opera House in Vienna he had accumulators, dynamos, and switches.

Is it not the fact that during the performance, when the lights were wanted, the electricity required was supplied solely from storage batteries?—A great deal of it was.

I mean that the dynamos were stopped while the lights were burning during the performance?—I am not aware of that.

I put it to you that during the performance the steam power was wanted for other purposes, and could not have been used for the dynamos?—That may have been a later development, but I cannot tell whether that was so or not, the work being carried out by my assistants.

What was the electromotive force of the current?—I do not know; it varied.

I put it to you it was 15 volts only?—It may have been. It was a special development of my system for a special purpose. During the daytime experiments were made and an even light was obtained.

Were not the batteries set up at Queen's Road ready charged?—They were sent up fully charged, but they had to be re-charged because some of the acid was spilt.

I put it to you that the batteries were charged, and that all they had to do when they were put in circuit was to discharge?—That was not so, as I ascertained by testing.

Did you use any instrument or means of ascertaining whether the current was coming into the storage battery, or what was the strength or potential of that current?—I judged by the governor of the steam engine, the pressure gauge, and the brilliancy of the lamps. These things were instruments in a sense.

Did the engine develop sufficient power to maintain all your lamps?—It did part of the time.

What was your steam engine capable of developing?—12 or 15 indicated horse-power. I cannot say what the voltage was, but I think it was 75.

From when to when were you connected with the Brush Company?—From the spring of 1881 to 1889, in different capacities. At first I was manager of the Lane-Fox department, the province of which was to develop my patents and others. It was a department devoted to incandescent lighting, as opposed to arc lighting.

Was the Brush installation put up under your directions?—To some extent.

It was found necessary to add switches and other services to make the system work?—That I altogether deny.

The people who had charge of the installation thought, rightly or wrongly, that it was desirable to add switches and other apparatus?—It may have been so.

The Brush Company was a wealthy and powerful corporation?—Yes. I pushed this patent, but the pressure against me was tremendously powerful both from within the Brush Company as well as from without.

That is why this patent was not brought into practical use?—It was not under my control. It was brought into practical use, but my merits and rights in the matter were successfully suppressed. The Brush Company were averse to litigation.

In answer to his Lordship, Witness said that from 1878 to 1881 he worked almost exclusively at his lamp. He then turned his attention to the batteries.

Sir Horace Davey: In 1881 there was the Electrical Exhibition at Paris, and you exhibited there?—I did.

Was there a suggestion that the soil should be used?—No, the connection was intended to be made by any available means—by a return wire.

The French people would not have it?—The return wire was made uncovered, and they objected to that. I complained that that was a great waste of money, and I am of that opinion still.

In answer to his Lordship, Witness said that he pointed out in his patent that the insulation of the return conductor in incandescent lighting was superfluous.

By Sir Horace Davey: The voltage of the lamps was about 60 volts.

Why did you not exhibit this wonderful invention at the Paris Exhibition?—As I have told you, my energies were taken up in producing the necessary incandescent lamps for that exhibition.

Do you say the Brush Company prevented you from putting up secondary batteries?—Yes, it prevented me from——

Will you pledge your oath that the Brush directors prevented you from putting up secondary batteries at Paris?—I do not know that the matter was argued, but I was limited as to funds.

There was a Lane-Fox department in the Crystal Palace Exhibition in 1882?—Yes.

There were no secondary batteries in that department?—No.

The Lane-Fox department was intended to show what the Lane-Fox department could do?—I am afraid it was not. There was a conflict between me and the directors.

Witness went on to say that Planté contemplated the use of secondary batteries with a Gramme machine, which was a common form of dynamo used at that time. In Planté's system the Daniell cells were the source of electricity, then he charged his magnets arranged in parallel for the purpose of actuating his brakes, and he had secondary batteries on his mains, his immediate mode of operation being that the current flowed from the Daniell's and, supplemented by the current from the secondaries, actuated the magnet which actuated the brake. The same was the case with the patent of Achard. Neither of these patents related to the same subject matter as his. He had delivered lectures upon his system of distribution of the electric light to public bodies. On May 17th, 1882, he lectured before the Royal United Service Institute, but that lecture was not intended to be a complete exposition of the method of electric lighting disclosed in his patent, though his system was mentioned and described in it. The lecture was a popular lecture, "On the Future of Electric Lighting," and he was asked to deal with the rudiments of the subject. In the course of his lecture he said that "It is not necessary that this external circuit should be composed entirely of wire. The earth is a good conductor of electricity." The earth there meant the soil as opposed to wire. The paper went on to say, "And may be substituted for the wire in the return of the circuit. It is not necessary that the current should be preserved from leakage by insulation. Returns by 'earth,' however, have wider signification than returns by actual earth. They include returns by conductors in which the return is uninsulated." That expressed his view then and now. He was endeavouring to explain the idea in a popular way that the return need not be an insulated one. In that paper he pointed out that the objects of putting up electrical reservoirs was to reduce the mains and to avoid the necessity of adjusting the plant to a maximum. He contemplated in his patent a small installation; he had not worked out all the developments necessary for a large system. He pointed out the advantages which would be derived from the use of the soil as part of the electric circuit in the same way as in telegraphy. He said they had in gas and water pipes a conductor which might be used. He knew the great cost of copper, and therefore he suggested making use of the conductors they had at hand.

In answer to Mr. Justice A. L. Smith, Witness said that he used metallic returns at Lady Conyers's and at the Paris installation.

Sir Horace Davey said that every successful installation had been by an insulated return.

Witness said that he contemplated that the generators would be 12 hours in charging the batteries. In 1884 he lectured before the Institute of Mechanical Engineers on "The Application of Electricity for Lighting and Heating for Domestic and other Purposes." He did not think any reference was made in the report produced to the use of secondary batteries in the description of the manner in which he kept the electromotive force in the mains constant. A good deal was said about it when he was lecturing. Specific references were omitted to a great extent, because many of the people he was lecturing to believed in nothing but what they could see, and he was unable to exhibit anything working. On December 26th and 27th, 1878—just after his patent was taken out—he wrote to the *Times*.

Having pointed out the necessity of a constant electromotive force, you suggest something other than secondary batteries?—I certainly made a slip in the use of the term condenser.

You do not allude to the office of the batteries as regulators, only as reservoirs?—I do not think so.

Mr. Justice A. L. Smith: If your point is that the patent only deals with these secondary as storers and not regulators, what is the meaning of storage to keep the electromotive force constant?

Sir Horace Davey said that of course that meant keeping it constant—supplementing the current by the storage battery, but——

Mr. Justice A. L. Smith said they would not argue: he saw Sir Horace's point.

Sir Horace Davey: You have seen our works?—Yes, but I did not see quite all I wanted to see.

We employ a dynamo or dynamos for charging the secondary batteries?—Yes, all your dynamos are connected with the mains on the system.

Are not certain dynamos reserved for the purpose of charging the secondary batteries?—Yes.

Does not the current of these dynamos pass through those batteries?—In some cases.

There are certain dynamos which supply the lights directly?—Some of those dynamos go to the lamps if they are connected.

Mr. Justice A. L. Smith: Do they ever work with the secondary batteries shut off?

Witness: I do not know. When I inspected them they admitted that the lamps and dynamos and the secondary batteries were all simultaneously in action.

It was here admitted by Sir Horace Davey that the defendants only worked their system with the secondary batteries being attached.

Sir HORACE DAVEY (to the Witness): Is it not possible to disconnect the secondary batteries with the mains?—Yes, but if the batteries were not connected they would not work.

In your system all the dynamos were intended to work in connection with the batteries, and there was no means of shutting off any dynamo from the batteries?—I have shown none.

Our secondary batteries are at the station?—Some of them, but not all of them.

With the exception of Queen's Gate there are no batteries dotted about the system as you suggest?—Not dotted about, but at two important points.

Is there a return by the actual soil?—There is where the insulator leaks.

Do you suggest that the defendants deliberately leave a leak?—No.

The defendants' return leads are insulated?—Yes.

Are the lamps such as are described in your specification?—Yes, they are lamps made under a license granted by the Brush Company, which I had to ratify.

They are the Edison and Swan lamps?—They come under the description furnished by my specification in this patent. They are lamps made by the Edison and Swan Company.

Are not the defendants' batteries constructed with a number of cells larger than that which would be necessary to give a current of the voltage required?—I really do not know what you are talking about.

The question was repeated, and the witness said the question was as nearly unintelligible as a question could be.

Did you inspect the batteries at South Kensington?—Yes. There were more than 50 cells in each battery.

Is there any provision in your specification for having a number of spare cells which may not be in use for the time being?—There is no mention of it.

Are not the defendants extra cells used for increasing or diminishing, as required the potential of the current?—Yes.

There is nothing of that kind pointed out in your patent?—No.

And there are mechanical connections by which certain of these extra cells may be brought into or thrown out of operation from time to time?—Yes.

Switching is the means used?—Yes.

There is nothing of that kind indicated in your patent?—No.

Re-examined by Mr. MOULTON: From what he saw at the defendants' works, the regulating action he had referred to took place.

Mr. JUSTICE SMITH asked the witness to explain the way in which the switch was put in operation and taken off; in other words, how a cell was brought into action and taken out again.

The WITNESS said the switches enable the operator to increase or to diminish the number of cells connected in series between the main and the earth. Another cell by a switch was brought into play by a boy working a lever.

Mr. MOULTON: From the time one cell is pegged in the condition is the same, and the regulating action the same, as shown in your patent?—Yes. When the potential is too low, they put on another cell.

Is switching in and out cells a matter that was new in 1878?—No; it was a matter so absurdly obvious, that I did not mention it.

Was all that the commutators in your patent of October, 1878, were meant to do to switch in and out?—Yes.

Before your patent had there been any system of distributing the electric light by means of the multiple incandescent bridge?—None.

Mr. JUSTICE A. L. SMITH pointed out that to succeed, the plaintiff must show that he made a machine that would work without an engine regulator and without a switch. The plaintiff had struck out, by disclaimer, his regulator, and must stand upon his amended specification.

Mr. MOULTON: Supposing we showed in our original specification an engine regulator, and found that was old, we should strike it out, but it would not follow that our specification was insufficient because of that.

Mr. JUSTICE A. L. SMITH: You mean upon the same basis as you left out the lamps when you found they would not do.

Mr. MOULTON said that was so.

To the witness: Do Swan's and Edison's lamps come within the description given in your specification?—Yes.

The substance chosen was not the material mentioned here, but carbon?—No, but it comes within the expression "suitable material."

After attention was attracted to carbon, did you experiment with it?—I had experimented with it long before. I was experimenting with it at the time of this specification, but could not get it to work.

You have said there was a combination to prevent the claims of your patent being put forward. Was there a close alliance between the E.P.S. Company and the Brush Company?—Yes, the directors of the E.P.S. Company were also directors of the Brush Company.

Was it to the interest of the E.P.S. that any patent controlling the use of the secondary batteries should be established?—Of course not, unless they controlled it themselves.

Were you able to get the claims of your patent put forward?—No, though I attempted to get my rights established.

At what date did you obtain control of your patents?—On December 3rd, 1889, when I at once commenced negotiations with various infringers.

In answer to his Lordship's question: What returns were known in 1878?—WITNESS said insulated returns, the use of gas pipes, uninsulated copper wire, and the soil were well known.

In answer to Mr. MOULTON, witness said that if there had been any difficulty in getting connection with the earth, any electrician in 1878 would have known that he could get the connection by putting a return wire. In his opinion no company would now insulate their returns if it were not for the Board of Trade. So far as the effective working of their system was concerned, they would not insulate their returns. After puzzling himself a good deal he had a vague recollection of seeing Mr. Crompton with reference to the installation in the Law Courts. If batteries and dynamos together would not keep the lamps bright, he should say the plant was not big enough, or that the batteries got short-circuited. In 1882 flannel as a separator was not generally used, and batteries very frequently got short circuited. The lamps were shocking bad lamps, that would not have worked properly with any installation. With regard to bursting the lamps whilst charging, no one following his specification would run his dynamo up so as to burst his lamps.

Mr. JUSTICE A. L. SMITH: Why?

WITNESS said because he would have time to moderate his engine when he saw the lamps get brighter than they should. The man in the engine room had a light by him. In his specification he contemplated the charging of the batteries when the lamps were on. In his opinion that was a sufficient direction to a man to moderate his engine so as to avoid the breaking of the lamps. There were instruments which showed the pressure on the mains. If the engine man kept the pressure as nearly as possible at 100 volts he would be safe.

Mr. JUSTICE A. L. SMITH asked how high 100-volt lamps could be run without any danger to them.

WITNESS said if raised to 110 the life of the lamp would be diminished. One could run a 100-volt lamp up to 105 or 106 without detriment to the life of the lamp. If the secondary batteries were large enough, the charge might be as low as 101. The smaller the batteries the larger would be the charge required.

Mr. JUSTICE A. L. SMITH: Why?

WITNESS: Because the smaller the battery the more resistance would be offered to the passage of the current.

By Mr. MOULTON: Bubbling had nothing to do with the operation of regulating. In his opinion, if large enough batteries were used, they would work without being bubbled, and the regulation would be far better. Batteries were very inefficient when bubbled. The bubbling or not bubbling of batteries did not in the least prevent their regulating the action when they were placed in the position he indicated.

At this stage the hearing of the case was adjourned until the following day.

TUESDAY, MARCH 1ST, 1892.

In further re-examination by Mr. MOULTON, Q.C., Mr. LANE-FOX said that the body of Achard's specification, in his opinion, showed that Achard's aim was to produce an intense momentary effect. There was nothing of a regulatory effect intended or obtained by Achard's specification. With regard to Clarke's, the directions were unintelligible, whatever intentions that patentee had.

Prof. SILVANUS PHILLIPS JAMES THOMPSON, the next witness, saying he was a member of the Society of Friends, was allowed to affirm. He said, in examination by Mr. MOULTON, Q.C., that he was a Fellow of the Royal Society, a Doctor of Science, and principal of the City and Guilds Technical College, Finsbury. He was a professor of physics; Prof. Perry was a professor of mechanical engineering. He had given his chief attention to electricity, and was the author of several works on the subject. In 1878 he was Professor of Experimental Physics at University College, Bristol. At that time he knew of Planté's batteries, had made them, and had met the inventor.

Mr. JUSTICE A. L. SMITH: Up to 1878 had any means been devised for making the electric light constant?

By Mr. MOULTON: Have you read the plaintiff's specifications?—Yes.

Do you know of anything in the literature of electricity, or in what has been published, which anticipates the plaintiff in any way?—I knew of nothing then, and I know of nothing now; it was an absolute revelation.

Was keeping the mains at a constant potential new?—Certainly.

Was feeding large numbers of lamps of the kind described in multiple arc new?—Absolutely.

Was regulating the pressure by batteries between the mains and the earth new?—Entirely.

Was regulating his steam engine by pressure on the mains new?—Entirely.

In your opinion, has anything been added to those to give us our present system of electric lighting. First, with regard to the lamps?—The lamp has been improved, but not altered in character. It is still a lamp coming exactly under the description given in the first page of Mr. Lane-Fox's specification.

With regard to maintaining the mains at constant potential?—There have been developments in the system of distributing the currents by means of mains. More mains than two are used. I am referring to the 3-wire and 5-wire systems.

The ATTORNEY-GENERAL pointed out that the other side had admitted that, for the purposes of infringement, the 3 and 5-wire systems were practically the same as the common 2-wire systems.

Examination continued: Electric governors on the steam engine, worked by currents from the mains, had been improved; there were several very successful forms of that. An electrical governor was not necessary for the system if secondary batteries were employed. The plaintiff's invention was properly set forth in his specification. He had examined Staite's patent.

Do you agree that that anticipates keeping the system at 100 volts? Certainly not.

Could this be intended to work at 100 volts?—Certainly not, because it works an arc lamp, which works at 40 to 45 volts. Staite invented the mechanism of the arc lamp, and this was the patent.

In what way was the term earth used in 1878?—In 1878 I was using the term earth as I use it now, meaning any conductor, whether insulated or not, but one that need not necessarily be insulated.

Witness here referred the Court to Culley's "Hand-book of Practical Telegraphy," published in 1878, and to Mr. John T. Sprague's "Electricity," in which he said any return conductor was called "earth."

Examination continued: Placing the batteries in series would exercise an equalising effect on the mains. The directions in the plaintiff's specification would enable a practical man to place the batteries in their proper position, as he was told to couple them together between the main and the earth. There was a great advantage in the cells having a large conducting surface. The effect of increasing the size of the conducting surface was that the equalising property came more perfectly into play. Having batteries at different points of the mains was also advantageous. Following out the directions in the plaintiff's specification, a practical man would get as perfect a regulation as he chose. If the batteries were placed as the plaintiff indicated, the regulating effect followed as a necessary consequence of the arrangement. The plaintiff's was certainly a workable system. There was nothing in the plaintiff's directions which would make a person working his system force the potential so as to break his lamps, nor ought the lamps to go down in brilliancy.

In answer to Mr. Justice A. L. Smith, who asked for an explanation of the process of switching, Witness said, that supposing there were 50 cells, and they were working at 100 volts, and they had not a large enough surface for the demand that was made upon them, their pressure would fall from 100 to 99 volts gradually, and would then fall from 99 towards 98. If, when the pressure fell towards 98, one additional cell was switched in, the pressure would then go up about 2 volts, from 98 to 100. If there were no other battery on the line when this cell was brought into play, there would be a momentary flickering in the lamp. If there were another battery on at some other part of the network of mains, the effect of that other battery would be to tone down the fluctuation caused by switching in one cell.

Mr. Moulton: They are not switched on and off continually?—Oh, dear no!

Between the times when they are switched on and off, is there any difference between the arrangements and the one described in Mr. Lane-Fox's specification?—None.

Examination continued: The regulating effect would still be there, because inherent, in the very circumstance that the battery was across the mains. In his judgment the batteries would work if they were used only within the limits the lamps would tolerate. The effect of switching out during the day was to get those cells not switched out charged more rapidly. Switching enabled smaller cells than would otherwise be useful for the purpose of obtaining a large discharge to be successfully used. Without switching, if one kept within the limits of one's lamps, one's batteries ought not to get under-charged or over full. He agreed with what Mr. Lane-Fox had said about Achard's and Clarke's patents. In his opinion the defendants used the system described in Mr. Lane-Fox's specification and claimed there. The defendants' returns were insulated, but he did not think they would insulate the middle wire if it were not for the Board of Trade; there was no advantage in insulating that but for one's neighbours.

Mr. Moulton said the Board of Trade ordered insulation in 1883.

Witness said there would not be much difficulty in making a soil return with the "three-wire" system. A 100-volt lamp of 10 candle-power of such goodness of manufacture that it would last 1,000 hours, if run at 101 volts, instead of 1,000 hours, would only last 785 hours, and its brightness would be increased to a little over 10¾ candle-power. In the case of a 100-volt lamp run at 105 volts, the lifetime would be 284 hours and the candle-power 13·3.

In cross-examination by Mr. Finlay, Q.C., Witness said that his reading of Staite's specification was that that patentee, in trying to define the amount of intensity, had said something between 190 and 36.

Is not the arc light carried on at a voltage of 100?—It can be; it is not usual.

Is it not carried on at Kensington at 100?—I believe it is.

Mr. Justice Smith: The question is whether, in 1847, arc lamps were worked at 100 volts.

Witness: There were no arc lamps except this one.

Mr. Finlay: What materials have you for saying that arc lamps should not be worked at 100?—You cannot alter the properties of carbon.

Our arc lamp is worked at 100?—Yes, because by special devices you choke off 45 or 50. There are no instructions for choking off in Staite's patent.

In 1847, would not 100 volts be employed for the arc lamp with the mechanism you have referred to?—It would work if you had it.

Witness was here taken through various passages in Culley's "Handbook of Practical Telegraphy," with a view of shaking his opinion that "the earth" did not always mean the globe. He maintained that any ordinary workman would have understood "the earth" to mean any return conductor. A telegraphic engineer, he said, used the word "earth" sometimes as the globe, in some places as the connection down to the soil, and in other places as a connection to a return conductor, not necessarily part of the globe.

Mr. Finlay: My question is—Is there a single passage in this book where "the earth" means anything but the globe of the earth, or a mode of describing the globe of the earth?—With the exception of where the iron sheath is spoken of, I do not think there is one passage in which the word "earth" is not used in one of these senses, either the earth or the wire which makes the connection down to the earth-plate.

Witness was next cross-examined with the same object and upon the same lines on Mr. Sprague's "Electricity," but he pointed out that putting the words "the earth" in quotation marks showed that a meaning was attached to them other than the earth of the globe, and maintained that that meaning was any return conductor.

Cross-examination continued: Witness said the plaintiff's whole specification was for a mode of distribution of the electric light at a constant pressure, and the plaintiff's arrangements were all described with that view, which meant avoiding change.

Is not the system described for the purpose of storing up the surplus force obtained when not much electricity is wanted, and giving it off when much is needed, that is, at night or in a London fog?—That is the way in which secondary batteries act if you charge them during the day and discharge at night, but the plaintiff stores a supply of current in these cells when not much electricity is being used, sufficient in quantity to keep the pressure up when there is a great draught on the mains.

The plaintiff's specification does not refer to preventing flickering?—It does not say anything about flickering.

Not a word?—No.

If the object of this was the storing of electricity, does not that point to charging your secondary batteries fully?—Storage was the means of effecting the object of keeping the pressure constant.

Can you charge your batteries without bubbling without running up to a pressure not dangerous to the lamps?—Yes.

Have you known any case of the plaintiff's system being adopted without switching?—Not in my own experience.

And extra cells which could be brought in and out?—That is the common practice.

At what increase of voltage do you think the life of the lamp would be destroyed?—I think at 300 volts the lamp would die suddenly. I have given you the data from which all other figures you want can be ascertained.

Re-examined: Staite's was the first arc lamp which had automatic apparatus in it. About 50 Grove cells were commonly used. Daniell's cells were usually used only for telegraphic purpose, and gave a very small current. There were not two lamps in series in Staite's system, but only one lamp. There was no trace of choking off the rest of the pressure. So far from there being anything to indicate that Staite meant 100 volts pressure outside the battery, the arc lamp would regulate the pressure at 45 to 50. In 1878 any electrician would know that for "earth" "return conductor" could be substituted if it were wanted. An electrician would have known in 1878 that if he wished to vary his secondary batteries, he would succeed in doing it by switching off or on one or more cells.

Prof. Wm. Fletcher Barrett, Fellow of the Royal Society of Edinburgh, Member of the Institute of Electrical Engineers, Member of the Royal Irish Academy and of other scientific bodies, Professor of Experimental Physics in the Royal College of Science, was the next witness.

Mr. Justice Smith: Before Mr. Lane-Fox, had anybody hit upon a device for keeping the electric light constant?

Witness: No. It was thought impossible to keep the electromotive force in the mains constant.

The Attorney-General: Or for keeping the pressure on the lamps constant?—No.

Nor for any system of distribution such as Mr. Lane-Fox describes? No. I find in Mr. Lane-Fox's specification the following novel points: 1. High resistance lamps made of a continuous conductor of refractory material; 2. A method of distribution of the current by sub-division in parallel distribution, solving the problem of what was then known as a sub-division of the electric light, usually attributed to Mr. Edison; 3. An arrangement whereby the electromotive force of the conducting mains may be kept as nearly as possible constant by a system of several generating engines, and a number of storage cells or reservoir batteries of large conducting surface. About seven years ago he put up an installation, which was now working at the Royal College of Science, in Dublin, in accordance with Mr. Lane-Fox's specification, which worked perfectly. He made no essential addition to Mr. Lane-Fox's system. In 1878 every tyro in electricity knew about switching in or out cells—it was common knowledge. Planté's cells were so much better than the supposed improvement of them (Faure's) that some of Planté's cells which he had used for six years were in good condition, whereas some of the improved ones used by a colleague of his became useless in two or three months. In 1878 "the earth" meant any kind of return conductor. His own laboratory, which was wired extensively, was put up in 1875 or 1876, and in it l = line and e = earth, but in every case e was an insulated return. He had no interest in this case except a scientific interest. He thought the greatest injustice had been done to Mr. Lane-Fox. The system of sub-division of the electric light, which was attributed to Mr. Edison, was really Mr. Lane-Fox's system. The remainder of the witness's evidence was a general corroboration of the evidence of previous witnesses.

Cross-examined by Sir Horace Davey: How is anybody to know what the plaintiff meant in his specification by very large conducting surface?—By trial and experiment.

What did that expression mean to an ordinary workman?—A very large conducting surface in reference to what was in common use at the time. If he were a man of common sense he would take a Planté cell five times as large as what he was in the habit of using, and that would do.

The workman must know the quantity of current the battery is intended to store?—Yes.

Can you give me any data from which the workman can calculate what sized battery would be required?—No.

How is the workman to get that data from the specification?—He is told that he is to use many batteries of large size at different points of his system, and it will work.

Sir Horace Davey: The gentlemen who instruct me are very confident you cannot work Mr. Lane-Fox's system without switching, and I understand you, gentlemen, to reply to that and say, "Yes you can,

if you follow Mr. Lane-Fox's direction of making the batteries with very large conducting surface."

Mr. GRAHAM: Our point is that the bigger you make them the better they will act.

Sir HORACE DAVEY: I have heard day after day that the reason why switches are required are because the batteries are not large enough.

Does your dynamo give sufficient current to light your lamps?—Yes.

Then you do not require your storage batteries to supplement the quantity of current required for your lamps?—I use them as reservoirs in the sense of regulators. That was the remarkable invention Mr. Lane-Fox made.

You do not mean to say that Mr. Lane-Fox invented the regulation?—Yes, I do most emphatically.

We have heard it was inherent in the system of storage?—He invented regulation in connection with the system.

You had some Planté batteries before 1878?—Yes; they were about 40 square inches.

They would have been no use for the purpose of your installation?—I do not know. My own batteries are only five or six times larger.

Did you use an insulated return for your installation?—I first used a gas and water return, and subsequently I used an insulated return to satisfy the requirements of the Board of Trade.

Was your gas and water return successful on the small scale on which you tried it?—Certainly.

Was there any electrolysis?—No.

The witness was under cross-examination when the Court rose for the day.

St. James's and Pall Mall Electric Light Company.—Arising out of an allotment of founders' shares in this undertaking, the Master of the Rolls and Lords Justices Fry and Lopes, on Saturday, in the action of Latimer Clark, Muirhead & Co. *v.* Francis, heard an appeal of the plaintiffs from a judgment of Mr. Justice Grantham, after hearing the case without a jury.

Mr. LAWSON WALTON, Q.C., for the appellants, said they complained that the defendant had been allotted more than his fair proportion of 100 founders' shares, under an agreement between the parties. Defendant being the promoter, and plaintiffs the engineers of the company, it was agreed that on plaintiffs paying the preliminary expenses, the shares referred to, to be issued by the company, should be divided between them, after satisfying thereout awards of one of these shares to each subscriber or placer of 200 ordinary shares. Mr. Justice Grantham had decided that the challenged allotment was correct, and this was appealed against partly on the ground that he had refused to hear evidence which plaintiffs alleged would have put a different complexion on the case; but after hearing the appellant's submissions in the matter, the Court decided that the decision was not to be complained of, and dismissed the appeal with costs.

Brush Electrical Engineering Company, Limited, v. Satchwell & Co.—Mr. Commissioner Kerr disposed of the case of the Brush Electrical Engineering Company, Limited, *v.* Satchwell, in the City of London Court, on Monday last. The plaintiff company, of 49, Queen Victoria Street, E.C., sought to recover £23 for supplying electrical fittings in April, 1891, to the defendants, Messrs. Satchwell & Co., auctioneers, of Bucklersbury, E.C.

Mr. POLEY, counsel for the defendants, said they entered into a contract with the plaintiff company to supply them with the electric light. To do this, of course, fittings, &c., had to be put up. That had been done, but it now appeared the plaintiffs could not put on the electric current, consequently the defendants could get no light.

Mr. POOLE, for the plaintiffs, said his company had no power to put on the light where the particular premises happened to be.

Mr. COMMISSIONER KERR said he never heard of anything so monstrous. The contract was obtained by misrepresentation, which in law amounted to fraud, and now the plaintiffs wanted to make the defendants pay for fittings although they could not use them.

Mr. POOLE hoped the Court would not brand the plaintiffs with misrepresentstion.

Mr. COMMISSIONER KERR: I do most unhesitatingly. Judgment for the defendants with costs.

Electrical Engineering Corporation, Limited, v. H. Binko & Co.—This action came before Mr. Commissioner Kerr in the City of London Court on Saturday last. Mr. C. A. White was counsel for the plaintiff company, of 58, Coleman Street, who sought to recover the sum of £55 15s. 6d., goods supplied to the defendants, Messrs. H. Binko & Co., of 24, Leadenhall Street. Mr. Ogle was counsel for the defendants.

Mr. WHITE said the action was remitted from the High Court. The defendants had admitted the claim, except so far as £18 7s. was concerned, and that sum was now in dispute. The defendants alleged that they had never received the goods for that amount. Mr. White said the goods were supplied.

Evidence was given, after which the case was adjourned until Monday, the 29th inst., when it was stated that the defendants had consented to judgment, which was entered for the plaintiffs, for the full amount, with costs.

Freter v. Metropolitan Electric Supply Company, Limited.—In the Chancery Division of the High Court of Justice on Wednesday, Mr. Justice Chitty had before him the case of Freter *v.* the Metropolitan Electric Supply Company, Limited, which was an action for an injunction. The plaintiff, Mrs. Freter, was the owner of the "John o' Gaunt" tavern, Sardinia Street, Lincoln's Inn, and she alleged that her business and premises were injured by the vibration caused by the engines of the company whose works were adjacent. Evidence was given for the purpose of showing that the engines were going night and day to the great annoyance of the customers and occupiers of the house, and to the detriment of the beer, it being said that the vibration made the "four ale" cloudy and unpalatable.

Witnesses were also examined in support of plaintiff's contention that the house was being shaken to its foundations, and was becoming unsafe, cracks already having appeared in the walls.

The defendant company denied that the vibration was caused by the working of their engines, and claimed to be protected by the Electric Lighting Acts.

After a lengthy hearing the parties effected a compromise on terms which were not stated in court.

NEW PATENTS—1892.

2,913. "Improvements in the electro-metallurgic extraction of zinc." G. NAHNSEN. Dated February 15th. (*Complete.*)

2,920. "An improved pole for supporting telegraph wires and the like." J. W. KNAUSE. Dated February 15th.

2,981. "Improvements in electro-medical appliances." P. A. CRAVEN. Dated February 16th.

2,992. "Improvements in systems of electrical distribution of heating currents." G. D. BURTON. Dated February 16th. (*Complete.*)

2,996. "An improvement in the construction of electric incandescent lamps." F. HOYER. Dated February 16th.

3,030. "Improvements in and relating to the lighting of railway vehicles by electricity, and to apparatus therefor." H. H. LAKE. (Communicated by the Consolidated Car Heating Company, United States.) Dated February 16th. (*Complete.*)

3,112. "Improvements in electric meters." S. Z. DE FERRANTI. Dated February 17th.

3,113. "Improvements in generating, transmitting and utilising currents of high tension, and in apparatus used for these purposes." S. Z. DE FERRANTI. Dated February 17th.

3,114. "Improvements in electrical primary batteries." C. THOMPSON. Dated February 17th.

3,120. "Improvements relating to galvano-plastics or the electro-deposition of metal." P. H. BEBTRAND. Dated February 17th.

3,145. "Improvements in electric globe and shade holders." J. WAITEHEAD. Dated February 18th.

3,158. "Improved means for aiding or communicating with ships from shore, or establishing communication between ships, or from ships to the shore." A. W. MCMURDO. Dated February 18th.

3,161. "Indicator of railway stations by electricity." J. H. AHRENS. Dated February 18th.

3,169. "Improvements in apparatus for establishing communication between vessels at sea, and vessels and the shore." R. L. DUFF. Dated February 18th.

3,211. "An improved electric switch." F. BROWN. Dated February 18th.

3,212. "Improvements in the application of electric light to roundabouts, and the like, which improvements are also applicable to advertising purpose." F. BROWN and P. COLLINS. Dated February 18th.

3,223. "Improvements in apparatus for electrically signalling the engine drivers or the guards of trains." G. WILSON. Dated February 19th.

3,233. "Improvements in apparatus to be used in connection with electrically driven machines." W. S. RAWSON, C. S. SNELL, and WOODHOUSE AND RAWSON UNITED, LIMITED. Dated February 19th.

3,234. "Improvements in electrical switches suitable for use in connection with electric launches and the like." C. S. SNELL and WOODHOUSE AND RAWSON UNITED, LIMITED. Dated February 19th.

3,238. "A gear spring lock action for glass holders of globes used on chandeliers, brackets, electroliers, &c." H. BISSEKER. Dated February 19th.

3,240. "Improvements in materials or compounds to be used in the manufacture of moulded articles, such as door handles, insulators for electrical purposes, boxes, toys, and other articles of the like kind." J. LANG. Dated February 19th.

3,244. "Improvements in the method of and apparatus for lighting by electricity circular switchback railways." W. MITCHELL. Dated February 19th.

3,283. "Improvements in electric arc lamps, specially applicable to search lights." J. H. TONGE, and LATIMER CLARK, MUIRHEAD, AND CO., LIMITED. Dated February 19th.

3,291. "Improvements in tubular electrical conductors." E. PAYNE. Dated February 19th.

3,297. "Improvements in electric meters." C. VOGT. Dated February 19th.

3,300. "Improved means for effecting the connection of electrical conductors." C. J. BARLEY. Dated February 19th.

3,314. "Improvements in and relating to the utilisation of alternating currents of electricity for producing motive power, for charging storage batteries and for other electro-mechanical and electro-chemical operations." C. B. BURDON. Dated February 20th.

3,366. "Improvements in dynamo-electric machines." T. L. HEMMING. Dated February 20th.

3,379. "Improvements in stoves, applicable especially to thermo-electric stoves." W. R. RENSHAW. Dated February 20th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

3,449. "Improvements in telephones." P. Rabbidge. Dated February 25th. 6d. Relates to improvements in telephonic apparatus, and its aim is to combine in an instrument of a small and compact form, the microphone, switches, call and telephone, and to obviate the necessity of unhooking or detaching any part of the instrument when in use. 3 claims.

3,799. "A new or improved solution or composition for charging electric batteries." A. Clark. Dated March 3rd. 4d. The inventor employs sulphuric acid, water, bicromate of potash powdered to saturation, sulphate of iron, and chloride of sodium or common salt. 2 claims.

3,895. "Improvements in apparatus for transferring electric car batteries." F. G. Corning. Dated August 5th, 1890. (Under International Convention.) 8d. Chiefly consists in a sectional charging bench, the several sections whereof are rotary upon vertical axes, whereby to reverse the positions of the battery trays thereon. 7 claims.

CORRESPONDENCE.

Electrical Organ Control.

Through an oversight an error in the position of a decimal point occurred in my last note as published in your issue of the 12th inst., *i.e.*, 1·8 watts should be read ·018 watts.

With regard to Mr. Hope-Jones's letter in your last issue, I think it is very difficult to draw a line of comparison in the efficiencies of the two actions, since (as far as I am aware) up to the present day, I believe, no illustration of his action has appeared in the technical press, nor have I seen any illustrated circular of the same.

In consequence, I can only speak of mine for the same being known to a great extent to Mr. Hope-Jones.

He, however, makes a mistake in saying my armature weighs three-quarters of an ounce; as a fact, it weighs collectively 5 grammes, *i.e.*, between iron diaphragm, aluminium wire stem, and wooden valve and leather; this is one-fifth rather than three-quarters of an ounce as stated. Formerly when the stem used to be made in silvered bright brass wire, and the iron armature slightly thicker than the present make, the whole thing weighed about 6½ grammes. However, these figures are not to compare with his armature as stated to weigh only $\frac{1}{64}$th of an ounce.

As already stated, the stroke of my valve is about 1 mm., what is the stroke of the Hope-Jones valve, as stated to be only a *small fraction* of the above? If the *small fraction* is something like about one-tenth of the above, then the law of inverse squares will militate greatly in his favour for reducing electric energy required to actuate the valve. As for the self-induction, I have no reasonst o change my former expressed opinion. The sparking at the contacts with my action is indeed very little, and even this small oxidation is entirely cleaned away by the rubbing action of the contact.

However, as I observe that in the construction of any machine or instrument the question of £ s. d. always comes to bear strenuously on the efforts of industrial men to carry things to the heights of perfection, it is to be hoped in the interest of the art of organ building, that Mr. Hope-Jones has succeeded in overcoming the said difficulty, and that the smallness of his armature may not be a reciprocal to its cost; for in such case our experience points to disappointment in the way of general adoption of things even superlatively good; inasmuch as the reduction in the cost of the keeping clean and recharging of a few more cells would hardly be sufficient reason to persuade the modern provincial builder to sink (in the primary construction of the instrument) a sum which is not even the double or treble of the sum now expended in the construction of sufficiently successful electro-pneumatic organs.

As for my part I am quite willing and agreeable to the proposal of Mr. Hope-Jones, and I should have no difficulty should he select the proper neutral ground himself to have the two actions tested side by side and considered in every respect, *i.e.*, efficiency, durability, facility of adjustment without expensive openings in the instrument, and relative cost, though I rather doubt the results would be of sufficient interest for the readers of your journal.

A. E. Conti.

Genoa, *February 22nd*, 1892.

The Electric Light in Montreal.

We beg to draw your attention to an item that you have published in the Electrical Review, under date February 5th, page 168, the first item in the column, headed, "The Electric Light at Montreal," in which you state that the Queen's Opera House of this city has recently been remodelled, and a complete installation of the electric light has been put in by the Edison General Electric Company, which is an error.

The facts of the case are that the Royal Electric Company of this city installed the plant, some 450 lights, complete, with the exception of a few fancy fixtures, which were bought from the Edison General Electric Company during the week in which the Electrical Exhibition was held in this city, and at that time were on exhibition at the Victoria Rink.

The Royal Electric Company also supplies the current for the Opera House from its central station system of the Thomson alternating system, and we are at the present time supplying current for 12,000 incandescent lamps throughout the city; consequently you can see that the Edison General Electric Company has taken a very small part in the fitting up of the Opera House in question, and we ask you to contradict the assertion.

The Royal Electric Company.

Montreal, *February 19th*, 1892.

Electric Light Fittings.

I think if some of the experiences which contractors have in fitting up houses on central station circuits were published they would in many cases be of value and interest to the trade in general, and might save a repetition of mistakes, which are very often exceedingly troublesome. I lately wired a house at 103, Gloucester Road; when tested in the first instance, the insulation between mains was only ·75 megohms, and the insulation to earth 1·4 megohms. I had some trouble to find out the reason of this, which I considered below standard, and found it was in the main cut-out, which was one of the old Edison type. I simply substituted for this a cut-out made on the "*H.I.*" *principle*, and the insulation was at once raised to 5½ megohms, which, under the circumstances, could not be surpassed.

This is an instance which I believe occurs very often, and proves that neglecting to use properly constructed fittings may occasion much trouble and unnecessary expense.

I. H. Scott.

February 29th, 1892.

Thefts at the Crystal Palace.

Will you kindly favour us with a little of your valuable space to call attention to the systematic theft which goes on at the Crystal Palace Exhibition.

In the early days we had several telephone receivers cut completely from the stations, and now we have just lost one of our micro-telephones, and also two model microphones from our revolving table.

We should be very pleased to hear whether other exhibitors have experienced the same thing, or whether we are the only sufferers.

The International Electric Company,
H. Oppenheim, *Manager.*

The Lalande-Edison Battery.

Can you kindly insert the following, referring to some recent remarks concerning the Lalande battery. I represented the same in New York City in 1885 for a London company and constructed a cell for the Western Union Company to test; it was left in their testing department for three months, and caused many remarks as to its not having shown any symptoms of local action. When working with these cells in 1884 I also found zincs being eaten away at the surface, and put this down to some action of the air on the surface, for by immersing the plates an inch or more this action was avoided; and I am of opinion it was this quality observable in the cell under test at the Western Union Telegraph Company's office, which finally led to its being taken up by an American company as being a good battery financially, and having a great future before it yet.

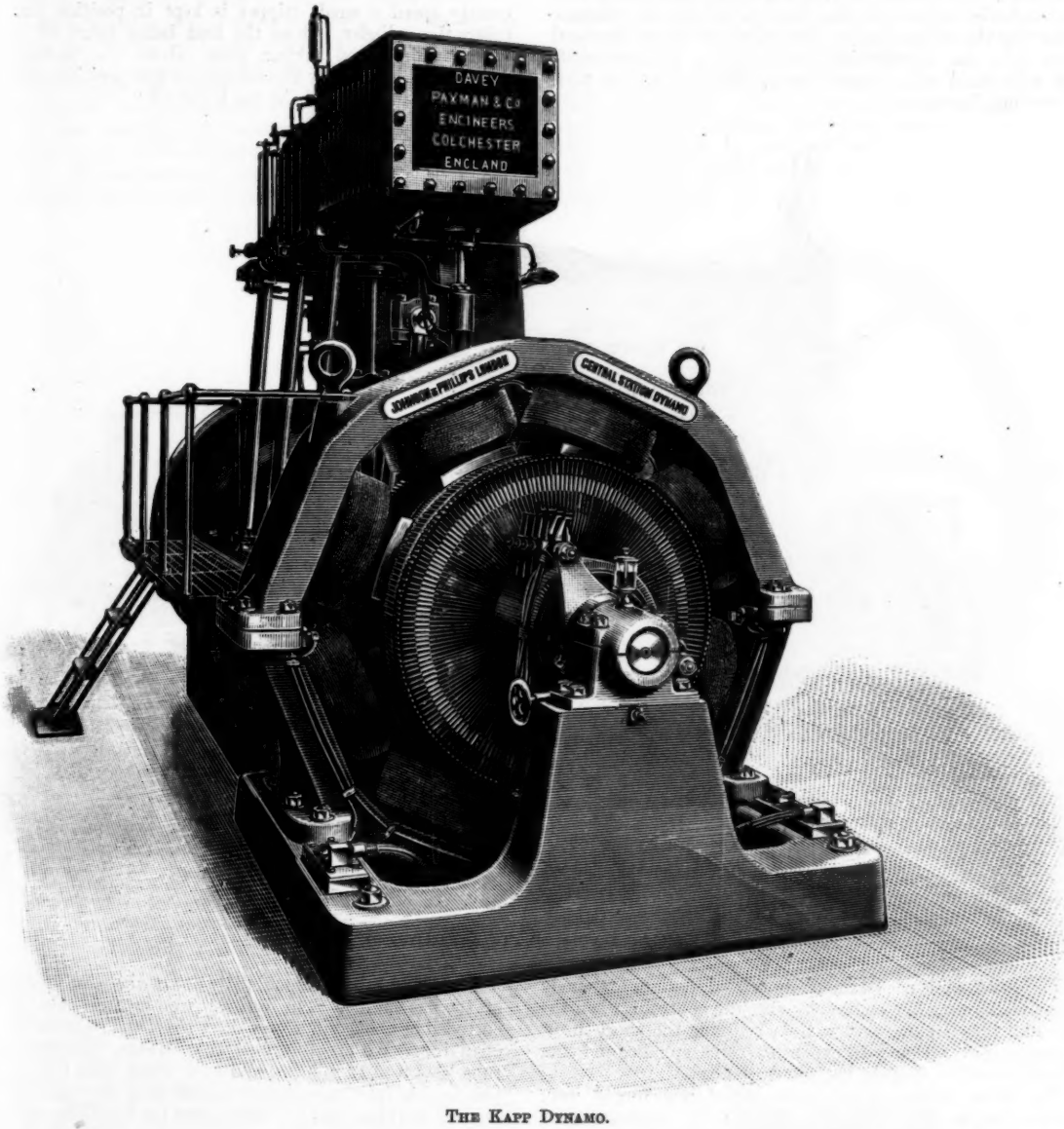
Geo. de Solome.

February 28th, 1892.

CRYSTAL PALACE ELECTRICAL EXHIBITION, 1892.

A Large Combined Plant.

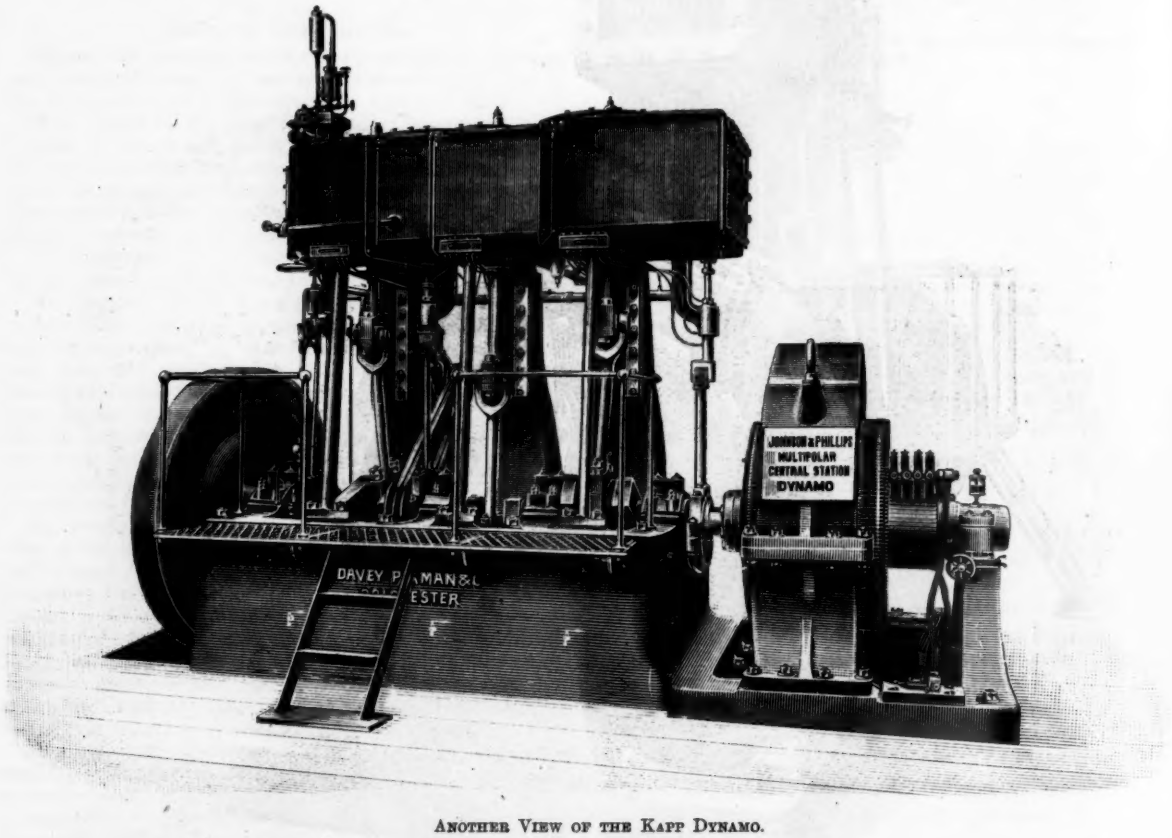
THE most striking exhibit at the Crystal Palace is a Kapp dynamo made by Messrs. Johnson and Phillips, coupled with a Davey-Paxman engine. The machine has 8 field poles projecting radially inwards from a massive cast iron yoke ring. The magnet cores, 14½ inches in diameter, are cylindrical in shape; the rectangular pole pieces are of cast iron. To facilitate the insertion of the armature the yoke is made in halves with horizontal joints, the top half can then be removed by the lifting rings. The armature core is 48 inches diameter by 18 inches long, and is built up of segmental plates threaded on steel bolts and secured between strong cast iron end cheeks. The power is transmitted to the armature conductors by 64 metal driving horns insulated with fibre and mica, the force transmitted by each driving horn being about 50 lbs. There are 362 bars on the armature, the ends being connected by segmental plates insulated from each other, and mounted in cast iron carriages, which are screwed to the end cheeks. This method of end connections has the advantage of leaving the ends of the armature open, thus securing excellent ventilation inside and avoiding the crossing of conductors over the ends, a source of trouble very frequent in the older methods of winding. The difference of potential between the adjacent plates is only 10 volts. The commutator contains 181 sections, and is 20 inches in diameter and 12 inches long. The current is taken off by two sets of brushes placed 135° apart, 4 brushes in a set. The machine is designed for an output of 550 ampères at a voltage which can be varied at will, from 200 to 260 volts. When the dynamo is charging batteries and a smaller current is required towards the end of the charge, the voltage may be forced up to 300^{V}. The speed of the machine under all working conditions is intended to be 130 revolutions per minute, but as a voltage of 205 volts only is required at the Palace, the engine governor has been adjusted for a speed of 115 revolutions per minute. The exciting power of the field-magnets can be varied by means of a rheostat so as to bring the voltage within the limits above mentioned. The brushes are adjustable by worm gearing. The current from the machine is used for lighting the Picture Gallery by incandescent lamps (fitted by the Gülcher Company), also for some Gülcher arc lamps and for a number of Brockie-Pell lamps, as well as for driving all the machinery on Messrs. Johnson and Phillips's stand. For



THE KAPP DYNAMO.

the latter purpose the current is passed through a pair of small balancing dynamos which split up the voltage into 70 and 130 volts, so as to make the current suitable for charging cells and work the ordinary type of machines exhibited on the stand.

The engine is triple expansion, having cylinders 12 inches, 18¾ inches, and 30 inches diameter respectively, with a stroke of 18 inches; it is built for an indicated H.P. of 350 at 140 revolutions, or 320 I.H.P. at 130 revolutions and 160 lbs. steam pressure; the floor space, including platform, is 10 feet 6 inches by 6 feet 9 inches, and from the floor line to the top of the cylinder covers is 11 feet, the extreme height to the top of the sight feed lubricators being 3 feet 2 inches more; the platform is 2 feet 8 inches above the floor level. The steam is supplied from Paxman's patent water tube boiler at 130 lbs. pressure, and for the purpose of starting the engine in any position, steam can be admitted direct into the intermediate steam chest; the crankshaft is of mild steel with slotted cranks 120° apart, and runs in four long bearings.



Another View of the Kapp Dynamo.

The governor is of Paxman's improved design, extremely sensitive, keeping the engine in absolute control; when the governor lifts it pulls over a link, bringing the short throw eccentric into action with expansion valve spindle, and cuts off steam earlier, keeping the speed constant.

The three main eccentric rods are of best forged iron, finished bright with adjustable bushes; the automatic gear is of steel with forked joints fitted with steel pins. The piston rods, crossheads, slippers and valve spindles are of forged steel, the latter being swelled to work in guides; the connecting rods are of best forged iron. The diameter of the fly-wheel is 6 feet.

Gas Engines.

At Stand 64 is exhibited the "Stockport" gas engine of Messrs. Andrew and Co., of Reddish, Stockport, and shown by their London representatives, Messrs. Bilbie, Hobson and Co., 80, Queen Victoria Street, E.C.

A 16 H.P. nominal "Stockport" engine can be seen driving an F-type dynamo by Mr. Wilson Hartnell, of Leeds, capable of supplying 280—300 16-C.P. lamps. This engine is said to develop 32 brake horse-power, or double the nominal horse-power, but it is somewhat doubtful whether this result could be expected for long continued working. Indeed, it is questionable whether the actual brake horse-power of any gas engine in continuous work, is much, if any, above the nominal rating of that engine. It is fitted with two fly-wheels, thus balancing the weight on the crank-shaft and equally dividing the strain on the bearings. The engine is also fitted with the latest improvements which include patent timing valve, patent governor and patent firing tube. The timing valve is so arranged that it is impossible for the engine, when being started by hand to turn backwards. The vibrating governor is exceedingly simple. A weight riding on a spring is moved by a vibrating lever and as long as the engine runs at a certain speed a small tripper is kept in position, and gas enters the cylinder, but on the load being taken off or any variation in speed taking place above the normal, the weight is immediately thrown into a new position, carrying with it the tripper, and the gas is cut off.

The firing tube is undoubtedly one of the most vital details of the gas engine. The ordinary iron or steel tube becomes corroded or choked in a very short time, and requires constant changing. We are informed that Messrs. Andrew's patent tube lasts 9 to 12 months, and even longer than this, and the bore is clear from corrosion or deposit from the first to the last hour of working, and in consequence the ignitions are always perfect.

The "Stockport" engine is driving with remarkable steadiness the machinery for the electric light on several neighbouring stands.

In connection with the "Stockport" gas engine, Messrs. J. E. H. Andrew & Co., Limited, are fitting a patent self-starter to all large engines free of charge. The starting of gas engines by hand has always been troublesome and laborious, and as there is a constant increase in the size to which gas engines are being made a practical success, the need of some efficient and inexpensive form of self-starter has become almost imperative.

Some years ago the usual method adopted (of what was termed a self-starter) was to form a reservoir of some of the

exhaust or other gases, under pressure, and then use this pressure to start the engine. This, however, was by no means free from danger, and above all added very considerably to the first cost of the engine, besides being constantly out of order, the difficulty being to retain the pressure. The next idea was to use a small gas engine to start the large engine; the objection to this need scarcely be pointed out. The latest idea is to use the cylinder of the engine itself. When a gas engine is stopped the cylinder is of necessity filled with air; if into this air a certain proportion of gas is allowed to flow, an explosive mixture will be produced. When the explosive mixture has been produced some method has to be taken to ignite it. M. de Botteville in the "Simplex" engine, used an electric spark from an induction coil and battery, others have attempted to utilise a percussion cap or cartridge. Later still, a gas jet has been placed outside an orifice from which the combustible mixture is escaping, and by suddenly turning off the supply of gas the flame flashes back into the cylinder, causing an explosion and the engine to start. All these arrangements, however, are uncertain and dependent on the skill of the operator knowing to the exact fraction of a second when an explosive mixture has been obtained, and taking steps to produce an ignition.

Messrs. Andrew's patent consists in the automatic firing of the charge in the cylinder as soon as a combustible mixture has been reached. The engine being stopped with the crank a little over the centre ready to start on an outward stroke, gas is allowed to enter the cylinder through a small valve kept open by a light spring which allows the valve to close automatically as soon as the superior pressure of an explosion occurs. The gas coming in under pressure drives out a portion of the air inside the cylinder. The only aperture through which the air can escape is through a similar valve fitted with a light spring and fixed to the top of the red hot ignition tube. After a space of time of about half a minute gas begins to follow the air through the aperture at the top of the ignition tube. As soon as this gas is in a sufficient quantity to form an ignitable mixture it is fired by the red hot tube through which it is passing; and once lit, the flame lights into the cylinder and ignites the whole of the charge, thus starting the engine.

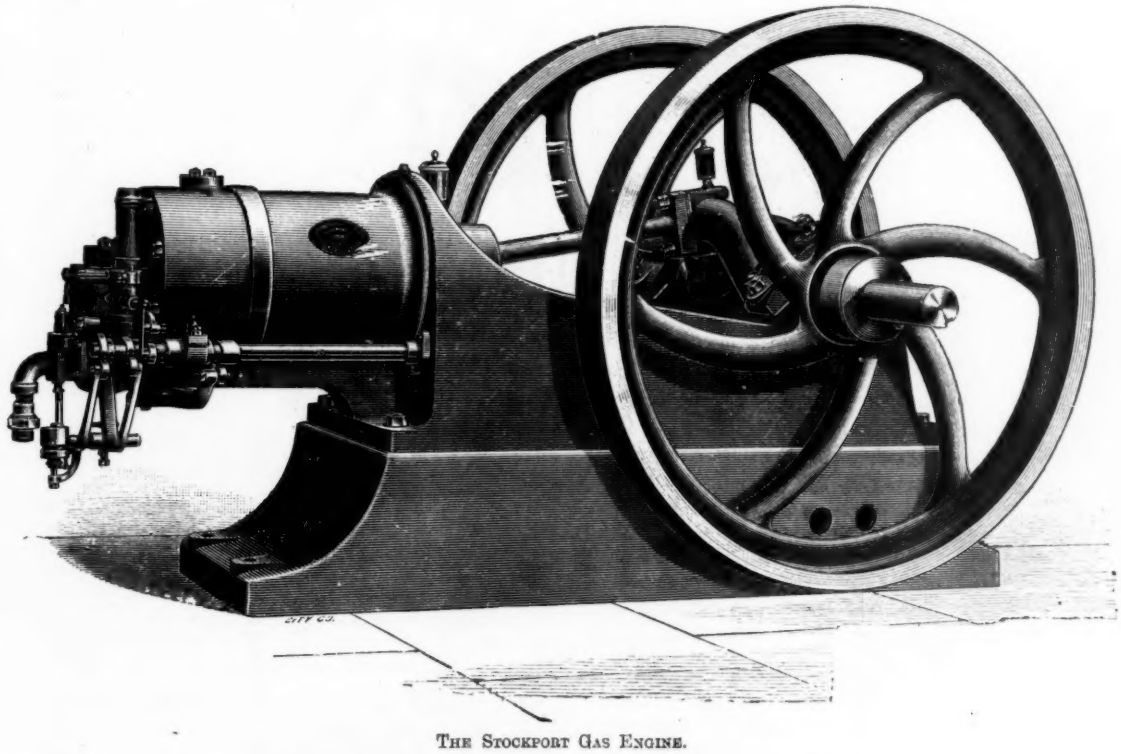
It will be seen from this description, that forming an explosive mixture in the cylinder of a gas engine, when the engine is at rest is old, but the essential part of this patent and its great superiority consists in the fact that the whole appliance is absolutely automatic; once the gas is turned on the engine itself does all the rest, thus practically getting rid of all chance of failure. This is the first time this appliance has been exhibited, and it will no doubt attract considerable attention.

This firm has recently supplied three engines to Messrs. Parsons, electricians, of Newcastle, for driving the dynamos on board two large war-ships that Messrs. Palmers, of Jarrow, are constructing for the Government. The installation, which is a very large one, driven by two 14 H.P. nominal engines and one 10 H.P. nominal engine, indicating altogether 88 H.P., is used to enable the workmen to complete the interior of the ships, working day and night. In this case the gas engines are fixed on board the ships themselves and the gas is led into the dock and on board the ship by a flexible hose.

This is rather a unique use of the gas engine, and clearly indicates its adaptability as a semi-portable engine.

D.P. Accumulator.

We are enabled to give a few more details concerning the D.P. accumulator. The sole concession in the United Kingdom is held by Messrs. Drake and Gorham. The accumulator may be said to have got well beyond the experimental stage, the cells having been in use in many important installations for the last two years. The plates are essentially of the Planté type, no oxides or salts of lead being used in their manufacture. An illustration of an unformed plate is given, from which it will be seen that it is laminated in structure, being composed of thin strips of sheet lead



The Stockport Gas Engine.

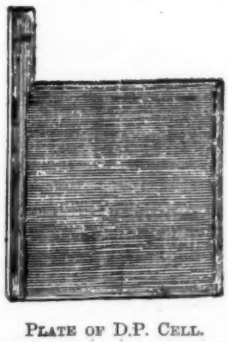
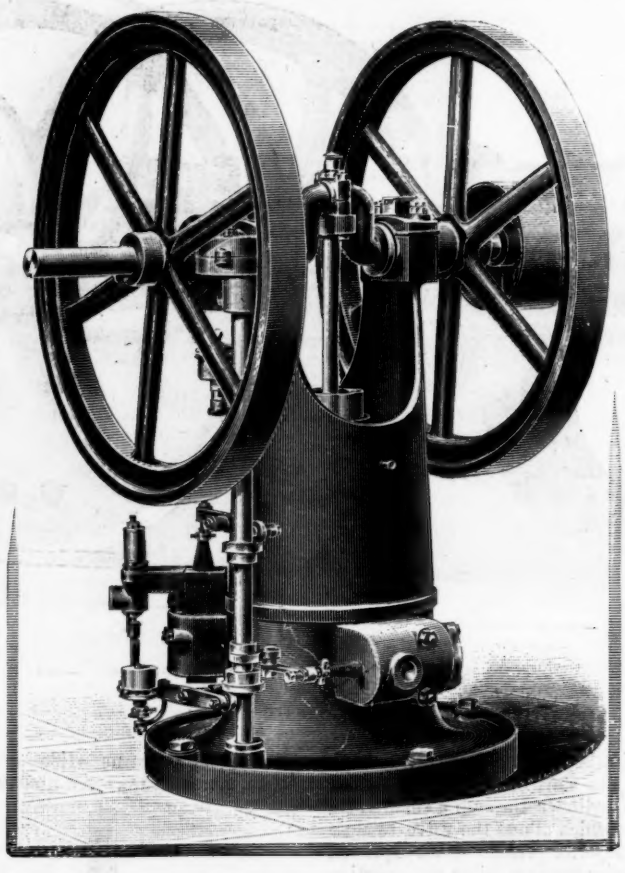


Plate of D.P. Cell.

built up one above the other and burned at each end, a space is left between each strip and the next, in which oxides are formed by a modification of the well-known Planté process. The plates are made partly under a concession for the Dujardin patents held by Messrs. Drake and Gorham, and partly under a number of secret processes which have been recently discovered. It will be readily seen that a plate of this description affords an enormous working area, and being quite free to expand in a vertical direction there is no tendency to buckling. It has been found possible to obtain a very great capacity per lb. of plate by using thin strips, but in this as in all lead batteries it is found expedient to leave a considerable body of uncorroded lead to act as a conductor, so that in the event of a cell being exhausted and the protecting coat of electrolytic peroxide thus destroyed, there will be plenty of metal to form a new coating.

A battery was at work throughout the whole of the Naval Exhibition in connection with Lieut. Wells's exhibit, and he speaks in the highest terms of its performance, although it was charged and discharged unequally and frequently exhausted.

The lists published by Messrs. Drake and Gorham show that the battery is about the same price as those of other makers when used to work a given number of lamps for nine hours, but it has this great advantage, that the same battery can be used for working about double the number of lights for a less time, without damage.



The Stockport Gas Engine.

As is well known, for rapid discharges the pasted form of plates is not found suitable, and the K type battery recommended for this purpose relies upon the Planté formation of the Tudor type of grid after the mechanically applied oxides are dislodged. It will thus be seen that Messrs. Drake and Gorham in adopting the Planté form alone, are merely going a stage beyond the practice which has been found so successful for rapid discharge batteries on the Continent and elsewhere.

Improved Electric Bell for Mines.

We illustrate a new form of electric signal bell, designed for use in collieries or mines where wet or dust interferes with the working of ordinary electric bells. In the bell illustrated, the working parts, coils, &c., are all enclosed in a cast-iron case, hermetically sealed, and with only the hammer and gong outside. The hammer is suspended in the centre of a flexible metal diaphragm, which allows it to move freely, at the same time doing away with the pivots or springs in use in other forms of electric bells. Connection is made to the bell coils by means of stout copper wires (No. 16 S.W.G.) insulated with India-rubber, which are brought through the case in "stuffing boxes," so as to prevent moisture from creeping along the wires into the bell. These wires can either be connected to the lines by a soldered and insulated joint, or coupled to them with binding screws. Both single stroke and trembling bells are made on this principle, and as they have so few working parts, and these are so well protected, they should find great favour with colliery engineers.